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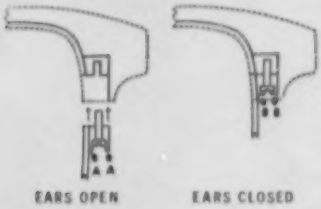

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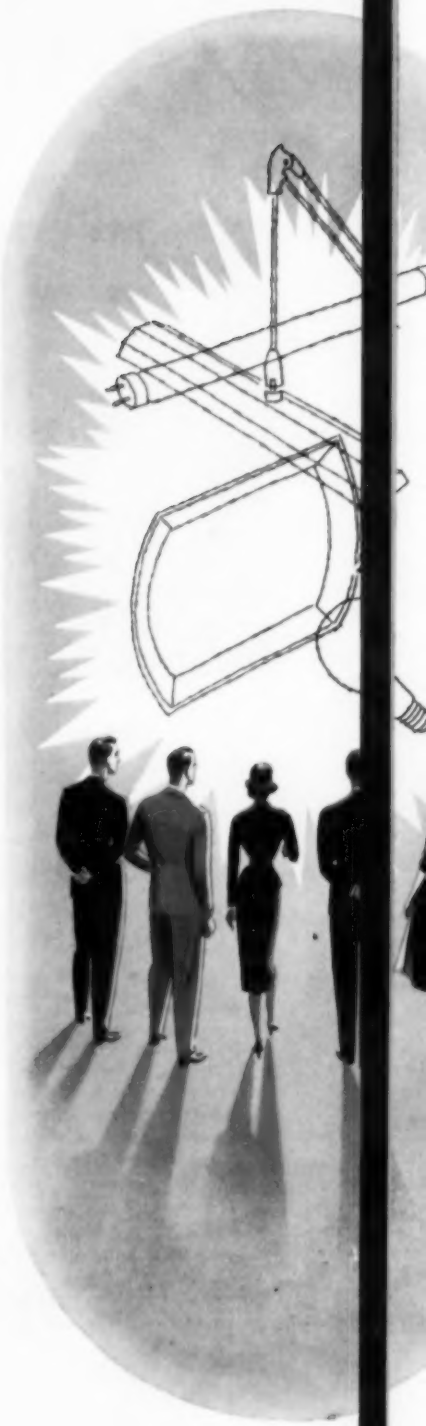

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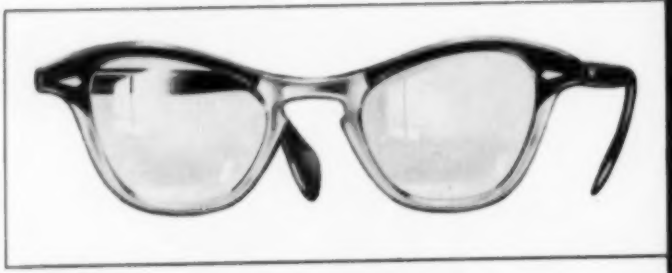

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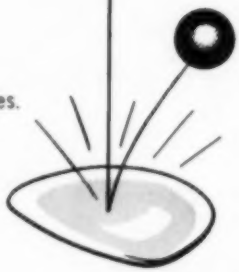

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PHYSIOLOGICAL FACTORS IN MULTIFOCAL CORRECTIONS*

I. MEASUREMENT OF OCULAR FUNCTIONS

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Southbridge, Massachusetts

Although the optical principles of near point corrections have frequently been analysed in technical papers, recent surveys indicate that practitioners neither always observe them in determining near point requirements, nor do they make full use of available corrective lens forms.

This paper aims at reviewing the physiological factors that may be measured routinely in clinical practice and making them the basis for determining the near point prescription. A subsequent paper—Consideration of Optical Functions—will discuss the selection of the near point correction in regard to optical efficiency and the patient's individual needs.

METHODS OF DETERMINING THE AMPLITUDE OF ACCOMMODATION

A. PUSH-UP METHOD

With the distance correction before the patient's eyes, a target showing fine print is gradually moved toward the patient and the distance for which he reports the beginning of the blur is expressed in diopters. This should be done monocularly as well as binocularly, and the results recorded as monocular and binocular amplitudes. If the patient is too presbyopic to see the print at a convenient distance (say, 20 inches), auxiliary lenses are added to the distance correction and their power is subtracted from the findings. For example, if auxiliary spheres of +2.50 D. are used and the patient reports a blur at 10 inches‡ (25 cm.), his binocular amplitude is 4.00 D. —2.50 D. = 1.50 D.

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*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 11, 1954. For publication in the February, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Fellow, American Academy of Optometry.

‡As usual in clinical practice, 40″ rather than 39.37″ are regarded as equivalent to 1 meter (1.0 D.) throughout this paper.

B. MINUS SPHERE TEST

A target with small print is placed at 16" and minus spheres of gradually increasing power are added to the distance correction until the first blur is reported. The amplitude of accommodation is then obtained by adding the minus sphere power, taken as plus, to 2.50 D., which is the accommodative demand for the target. The test should be made monocularly as well as binocularly. If the patient is too presbyopic to see the print at 16" with his distance correction, auxiliary spheres of +2.50 D. should be added. Then, the minus sphere that can be overcome measures the amplitude of accommodation.

DYNAMIC CROSS CYLINDER TEST FOR DETERMINING THE ADD IN PRESBYOPIA

At 16", a white card showing a "grid" consisting of three vertical and three horizontal fine black lines is presented to the patient wearing his distance correction. The vertical and horizontal lines should appear equally clear if the astigmatism at the near point is fully corrected. If one set of lines appears clearer than the other, the cylindrical correction should be changed until both appear equally clear, just as in the subjective astigmatic test for distance. When they do appear equally clear to each eye (or equally blurred in case of presbyopic patients), +0.50 D. cross cylinders, with minus axes vertical, are added to the lenses before the patient's eyes.

If the patient accommodates exactly for the target at 16" (2.50 D.), the cross line grid appears equally clear since the image of the horizontal lines is half a diopter in front of the retina and that of the vertical lines half a diopter behind the retina. If the patient accommodates more than 2.50 D., the vertical lines will appear clearer. In situations such as presented in this test, the patient usually relaxes accommodation so that the horizontal lines appear clearer. First the test may be made monocularly, then binocularly. Plus spheres of gradually increasing powers are added until the vertical lines appear clearer; then the spherical power is reduced until the lines appear equally clear. When this has been accomplished, the difference between the total lens power before the eyes and the distance correction represents the "add" for the particular near test distance. The binocular test usually yields a slightly lower add than the monocular test.

VERIFICATION OF THE NEAR CORRECTION: "METHOD OF LIMITS"

With a tentative near correction determined by one or more methods such as outlined above, a further monocular and binocular test may be made by noting the range through which fine print appears clear. The ranges should be equalized *dioptrically*, rather than linearly.

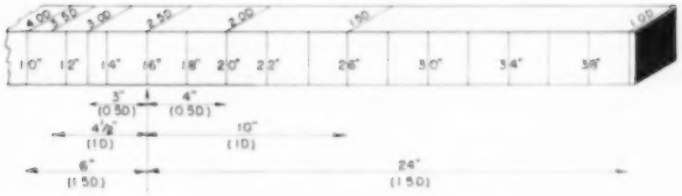


FIG. 1 DIOPTRIC AND LINEAR RELATIONSHIPS IN BALANCING THE RANGE OF CLEAR VISION ABOUT AN OPTIMUM NEAR POINT OF 16"

For example,* (Figure 1), if the patient's average near working distance is 16" (2.50 D.), the ideal correction would enable him to see clearly at 10" (4.00 D.) and also at 40" (1.00 D.). The corresponding *linear* range is 24" (40" — 16") beyond the usual near point and 6" (16" — 10") inside of it. However, the *dioptric* equivalents of these ranges are equal: namely, 1.50 D. on either side of the average near point.

Another example: A patient has an amplitude of accommodation of 2.00 D. and an add of +1.50 D. for a 16" working distance, so that half his amplitude is held in reserve. Clear vision out to 26" is possible when the accommodation is relaxed, and in to about 11½" when the accommodation is fully used. This represents a range of 10" beyond and 4½" inside the usual working distance of 16". While these *linear* ranges are unequal, their *dioptric* equivalents (1.00 D. either way) are balanced.

An older person's (amplitude of accommodation about 1.00 D.) ideal correction for 16" would give him clear vision from 13" (3.00 D.) to 20" (2.00 D.), that is, the equivalent of 0.50 D. on either side of his customary near point. *This procedure automatically determines an add that leaves half the patient's amplitude of accommodation in reserve at his preferred near point.* Therefore, a final check of the near correction is to see whether it does leave half the amplitude in reserve.

Instead of moving fine print beyond and inside of the customary near point, this "Method of Limits" may also be applied by adding plus and minus spherical lenses. This is done conveniently with the phoroptor rather than with the trial frame and trial lenses. The target is placed at the preferred reading distance, and plus spheres, then minus spheres are added until the limits of clear vision are ascertained. The

*In the examples, as in actual clinical practice, no allowance is made for depth of focus or the influence of proximity. As Hofstetter[1] has pointed out, these factors can be assumed as constant for the same individual and hence as affecting all findings by the same amount.

add that results in equal dioptric ranges about the preferred near working distance (which may be 20″, 16″, 15″, 13″, or any other distance) will leave half the amplitude of accommodation in reserve. As mentioned before, monocular as well as binocular tests should be made. The binocular amplitude of accommodation is normally greater than the monocular amplitude, and, consequently, the add determined under binocular conditions is slightly less than that determined for monocular vision. Clinical experience has indicated that it is better to prescribe the smaller binocular findings.

Since the binocular findings usually determine the final prescription, one may wonder why monocular tests are advisable. In unusual cases where the binocular findings differ significantly from the monocular ones, we may suspect some anomaly of binocular vision. Furthermore, monocular tests are helpful in that they reveal any existing difference between the amplitudes of accommodation of each eye. While unequal monocular accommodations (or unequal accommodative responses) are always a possibility, especially in pathological or high anisometropic cases, they frequently indicate a spherical imbalance of the distance correction. For this reason, the monocular near tests serve as an excellent check of the distance prescription. When the amplitude of accommodation seems greater in one eye, a recheck of the distance findings will usually show that more plus (or less minus) can be added before the eye having the smaller amplitude of accommodation.

The "Method of Limits" is a standard scientific procedure used in testing other psycho-physiological functions. However, as an aid in determining presbyopic adds, the significance of equalizing the *dioptric* rather than the *linear* range of clear vision has not been fully appreciated. To repeat, the add that provides equal dioptric ranges about the preferred near point, whatever this may be, leaves half of the amplitude of accommodation in reserve. The procedure is very simple, and adequate clinical evidence exists to support the advisability of "leaving half the amplitude in reserve."

Laurance,[2] Maxwell,[3] Mason,[4] Tait,[5] Borish,[6] Knox and Ellerbrock,[7] and others have written about the advisability of leaving at least one-half the amplitude in reserve. At the Dartmouth Eye Institute where the technique of binocular stigmatoscopy[8] was used in aniseikonic cases following the routine refractive procedures, I was impressed with the close relationship between the add determined by stigmatoscopy and that determined by leaving half of the binocular amplitude of accommodation in reserve. Unfortunately, stigmatoscopy is not used in routine clinical practice.

Since the average practitioner appreciates more fully a relationship between data obtained by methods with which he is familiar, it is noteworthy when several refractionists using their own various methods obtain similar results. If it could be shown that several clinical methods of determining near point adds result in data closely agreeing with that obtained by leaving half the accommodation in reserve, then, such a simple procedure ought to be more widely used. Actually, such an agreement is shown in Hofstetter's[9] "Survey of Practices in Prescribing Presbyopic Adds."

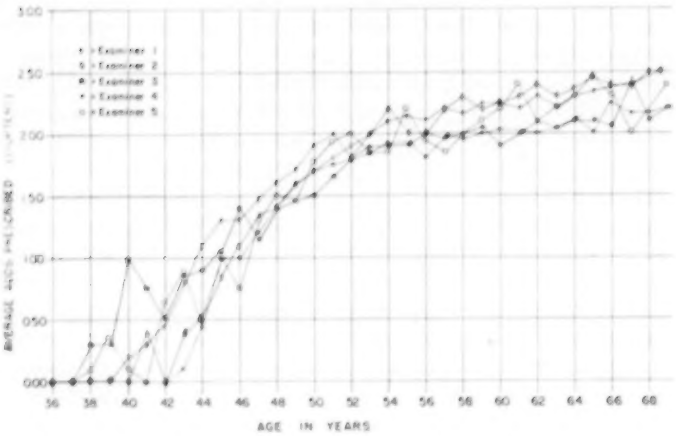
Hofstetter[9] concluded that the practicing optometrist is resorting to criteria which have not as yet been adequately described because of the lack of agreement between the average adds actually prescribed and the several add tables based on age, or on rules of thumb which, in turn, depend on the amplitude of accommodation and an assumed reading distance. Nevertheless, Hofstetter did mention "the remarkable similarity between the average add curves of the several individual optometrists in the survey." This, to me, is the most significant finding. A total of 3,927 patients were involved; 1,721 were males, and 2,206 were females. They were patients encountered in routine practices, and it may be assumed that the majority had been given "successful" prescriptions. The methods or criteria described by the optometrists involved in Hofstetter's survey may be summarized as follows:

1. "Endeavor to balance the fused cross cylinder findings at 40 cm. against the Donders' age-amplitude table and the working distance most used by the patient."
2. "On age as a tentative guide with adjustments indicated by the accommodative range test and allowances according to the occupation and the expected working distance."
3. "Use of a tentative near finding that enables patient to barely get best acuity at near, subject to verification by the use of binocular cross cylinders in a trial frame."
4. "On the maintenance of half of the amplitude in reserve."
5. "Judgment of four clinical instructors, each free to employ his favorite criterion for determining the reading add, and these criteria may be presumed to have varied considerably."

It will be noted that No. 4 is the simplest, most definitive description of a criterion for determining a near point add. The graphs* in

*Hofstetter plotted both the averages of adds greater than zero and the averages of adds including zero adds. This resulted in two divergent curves between ages 46 and 36 to which Hofstetter referred as a "statistical artifact." He also mentioned that: "The marked irregularities in the trend of the more-than-zero adds at the lower age levels are accounted for by the small samplings of individuals for whom adds are pre-

FIG 2 COMPOSITE GRAPH OF DATA FROM HOFSTETTER'S SURVEY (1,721 MALE PATIENTS)



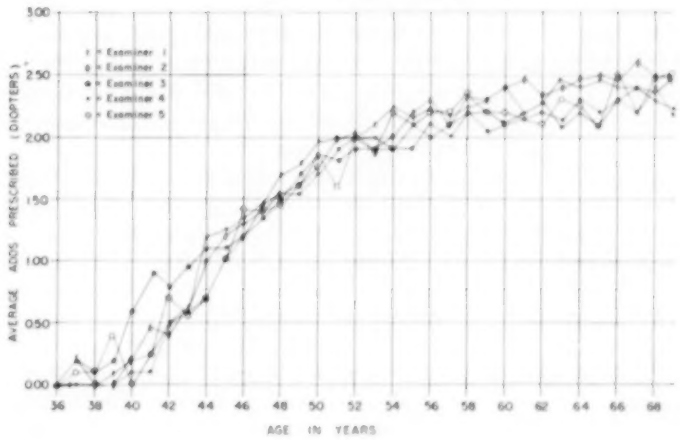
Figures 2 and 3 are an enlarged composite of the male and female data from Hofstetter's survey. It is remarkable how closely the data for various age levels agree. Although the students in the Optometry Clinic, according to Hofstetter, frequently reported that the adds arrived at by the "one-half in reserve" rule are almost always less than those adds the clinic instructors actually prescribed—an observation which started the survey—nevertheless, the data of the four clinical instructors in the accompanying graphs are practically indistinguishable from those of the other optometrists, including the one (No. 4) who used the criterion of "one-half in reserve." In fact, from the similarity of all the data it would appear that all the clinicians, knowingly or unknowingly, had kept half the accommodation in reserve.

Since the data of the various clinicians agree so closely and presumably resulted in "successful" prescriptions, it seems to follow that the simple criterion of "keeping half the accommodation in reserve" can be recommended in preference to other more involved criteria. Furthermore, as pointed out earlier in this paper, the "Method of Limits," that is, the equalization of the *dioptric* ranges of clear vision can be recommended as a valuable means of checking whether a certain add does leave half the accommodation in reserve.

Though it is desirable to ascertain the spherical power for the

scribed." For these reasons, the composite graphs in this paper (Figures 2 and 3) represent the combined zero adds and the adds greater than zero.

FIG. 3 COMPOSITE GRAPH OF DATA FROM HOFSTETTER'S SURVEY (2,206 FEMALE PATIENTS)



patient's customary working distance by as unequivocal a method as possible, it does not follow that other factors such as motility, the patient's previous correction, and his individual needs should be disregarded. The following section gives a review of the essential binocular neuromuscular aspects of near point corrections.

MOTILITY FINDINGS

Before the onset of presbyopia, the patient had used for near work a certain pattern of association between his accommodation and convergence. With the reduction of the accommodative demand by the addition of plus lenses, the stimulus to convergence associated with accommodation is likewise reduced. The patient must learn to converge without the help of accommodative convergence.

Maddox[10] was one of the first to indicate that convergence does not depend entirely upon accommodation. He maintained that convergence is composed of four parts: (1) tonic convergence; (2) accommodative convergence; (3) psychic nearness convergence; and (4) fusional convergence.

Morgan[11] and others have more recently pointed out that the extent to which convergence is associated with accommodation (A.C.A. ratio or gradient) may be ascertained by simple measurement. Reading at 13" normally requires about 18△ convergence and 3.00 D. of accommodation, a ratio of 6 to 1. Measurements of accommodative convergence on a great number of patients indicate that, on the average,

3.5△ to 4△ convergence are associated with each diopter of accommodation. While the A.C.A. ratio may be different for different individuals, it has been shown to be substantially constant for the same individual. Thus, a patient whose A.C.A. ratio is 4△ convergence per diopter of accommodation is deprived of 6△ convergence when he is given an add of +1.50 D. O.U. at the near point. He will either see double, or suppress one image, unless the loss of 6△ accommodative convergence can be made up by *"fusional convergence."*

Fortunately, most presbyopic patients readily learn to supply the proper amount of *fusional convergence*. This is true especially if the first add prescribed is not too great, i.e., does not require too radical a change from the pattern previously used for close work. When a person postpones examination of his eyes until he requires an add of +1.50 D. or +2.00 D., he may experience discomfort in adapting to a full correction. In such cases, it is good clinical practice to prescribe initially not more than 1.00 D. and to increase this add by not more than half a diopter after a period of several months. In this way the patient can learn more gradually to provide the required fusional convergence.

The decrease in accommodative convergence is shown by an increase in exophoria at the near point and a decrease in positive relative convergence measured by prisms base-out to diplopia. The increase in exophoria at near need not, by itself, cause any concern. Despite a high exophoria at near, no difficulty will be experienced if the fusional amplitudes are adequate. However, when the prism convergence at the near point is too low to comfortably overcome the exophoria, consideration must be given to either (1) convergence training by orthoptic exercises, (2) prescribing base-in prisms, (3) reducing the plus sphere addition to a minimum, or (4) a combination of these procedures.

Since the binocular neuromuscular functions, given adequate stimulus and time, are often remarkably adaptable, the practitioner should not always expect difficulty when the motility findings, taken with a new add, seem inadequate. The first data may show insufficient convergence but, after several hours or a few days, the patient may have developed adequate fusional convergence, making convergence training or base-in prisms unnecessary. Of course, it is not always possible to determine in advance whether this fortunate circumstance will prevail in a given case.

Older patients are less likely to overcome an insufficiency of convergence than younger ones. Fortunately, older people usually require only a minor change (0.25 D. or 0.50 D.) in their adds, since the greater part of their presbyopia has already been corrected. Hence, the

amount of accommodative convergence lost by a further increase in add is slight. If the patient has had no previous convergence difficulty, it is not likely that a small increase in the add will cause some. However, patients with a poor amplitude of convergence who have worn an add for several years are likely to require convergence training or base-in prisms.

CONSIDERATIONS IN ANISOMETROPIC CASES

Unequal vertical prismatic effects at reading points below the optical centers of anisometropic corrections have frequently been a matter of concern because it is assumed that, in reading, the patient lowers his gaze by an equal angular rotation of each eye. Many patients who wear anisometropic single vision lenses learn to avoid much of the prismatic effects by lowering their head, instead of their eyes, and looking through (or very nearly so) the optical centers of each lens. However, in the case of bifocals or trifocals, the patient must lower his gaze to see through the segments. It is true that anisometropic lenses have unequal prismatic effects 10 mm. below their optical centers. For example, lenses differing by 3.00 D. in the vertical meridian have, according to Prentice's Rule, a prismatic imbalance of 3△ at 10 mm. below the optical centers. Some clinicians correct for this *calculated* imbalance by various methods: dissimilar segments; slab-off prisms; prisms in segments; vertical decentration of the lenses.

The correction of the *calculated* vertical prismatic imbalance in anisometropic lenses is often clinically unsuccessful. It is incorrect to assume that each eye makes the same angular depression or that the visual axis of each eye is depressed by exactly the same amount. Clinical experience has shown that the asymmetry of anisometropia is often accompanied by other asymmetries, not only facial and general physical asymmetries, but binocular anomalies such as heterophoria, anisophoria and aniseikonia. For this reason, the correction of *calculated* vertical prismatic imbalances in anisometropic cases may subtract from rather than add to a patient's visual efficiency and comfort at the reading level.

In anisometropic cases, it is important to *measure* the vertical phoria and fusional amplitudes while the patient is looking through the reading portion of his near correction. It is not possible to do this with the phoroptor and, sometimes, it is even misleading to use trial lenses in a trial frame since the patient may not look through the areas of the trial lenses which correspond to his bifocal segments.

Most patients who require a significant distance correction have glasses which may be used for the phoria and fusional amplitude tests. It is important to measure also their basic or inherent phoria obtained

without any glasses so that the effect of the refractive correction upon the phorias may be determined. Both sets of measurements should be made at distance and, with depressed gaze, at near.

A spot of light is sufficient for distance fixation and a Maddox Rod or dark red glass for breaking fusion. A Hughes rotary prism is convenient for measuring the phoria and also for determining the fusional amplitudes. At near, a spot of light from a pen pocket flashlight or an unshielded ophthalmoscope lamp may be used. The Maddox Rod should be large enough so that the patient can see through it when his gaze is lowered for near fixation. A multiple Maddox Rod, 2" in diameter and mounted in a ring on a 6" handle is most convenient. If a red glass is used, it should be dark enough to permit only the fixation light to be seen to the exclusion of all other objects that might stimulate fusion. By holding the fixation spot himself, the patient may simulate his reading position while the doctor holds the Maddox Rod (or red glass) and the Hughes rotary prism.

Ellerbrock and Fry[12] have demonstrated that anisometropic patients devolop "a capacity for compensating vertical prismatic inequalities at the straight forward and reading positions." That is, no significant vertical phorias could be measured in the straight-ahead (distance) and lowered reading positions even though considerable vertical prismatic inequalities were present in the lenses. Furthermore, as the phorias became adjusted to the prismatic inequalities at the two positions, the midpoint of the vertical fusional amplitude shifted accordingly.

In a subsequent study, Ellerbrock[13] has indicated that both the fusional movements of the eyes as well as the variable compensation to the prismatic imbalance of anisometropic lenses are used in maintaining single binocular vision. He also found that when the demand upon the fusional reflex was removed and the eyes returned to the fusion-free position, the variable compensation to the prismatic imbalance of the lenses remained.

Although a physiologic "compensation," as indicated by the above studies, explains the absence of a significant vertical phoria through periperal portions of anisometropic lenses, it is also possible that another factor is operative. Friedenwald[14] has termed as "anisophoria" the condition in which the phoria varies in the different directions of gaze. In cases of anisometropia, an anisophoria can often be found without the corrective lenses. If this inherent vertical anisophoria is opposite but approximately equal to the prismatic differences introduced by the corrective lenses, no significant hyperphoria will be measured at the reading level through the lenses. As an example, let the right lens

differ from the left by +2.00 D. At a reading level of 10 mm. below the optical centers the lenses (not the eyes) have a prismatic imbalance of 2△ base-up with respect to the right lens or base-down with respect to the left lens. Without lenses, no vertical phoria is found at distance, but a left hyperphoria of 2△ is measured in the lowered reading position. This inherent anisophoria is automatically corrected by the prismatic imbalance of the anisometropic lenses or, expressed differently, the inherent anisophoria compensates for the prismatic difference of the lenses. In this manner, rather than induce a vertical phoria at the reading level, the prismatic imbalances of anisometropic corrections are often eliminated by an inherent anisophoria.

Lebensohn[15] has pointed out in a clinical study of 200 anisometropic cases that: "The vertical anisophoria found without lenses has major tendencies whereby neutralization of anisometropic anisophoria is more or less effected either automatically or by the prism correcting the distance hyperphoria." This means that it is frequently unwise to correct the computed vertical prismatic difference in anisometropic lenses, since many patients have inherent vertical anisophorias which balance these automatically.

It may well be that the physiological compensation described by Ellerbrock and Fry and the inherent anisophoria discussed by Friedenwald and Lebensohn work hand in hand in certain anisometropic cases. Of course, their effect is not always adequate: in some cases a residual hyperphoria remains. This is why it is important to *measure*, rather than calculate, the phorias and the fusional amplitudes with and without glasses at distance and in lowered reading positions.

When a significant vertical phoria is found by actual measurement, it may be corrected by decentration or by grinding prism in the lenses. Frequently, the vertical phorias at distance and near are such as to permit a compromise correction through a prism in the entire lens rather than in the segment only. However, when the vertical phoria for lowered near fixation is significantly different from the distance phoria, it is best to use prisms ground in the segments rather than dissimilar segments. The unequal fields and the unfavorable cosmetic effect of dissimilar segments are often too much of a disadvantage. Similarly, slab-off prisms usually meet with more patient-resistance than prismatic segments. Lebensohn's[15] suggestion of using unequal curves and thicknesses in eliminating prismatic imbalances may be helpful in cases where the induced size difference tends to correct the aniseikonia due to the anisometropia. However, if it does not, the resulting aniseikonia may cause more discomfort than the prismatic imbalance at the

reading level. In general, it is unwise to risk substituting one error for another when, by proper tests, it is possible to determine which error, in this case anisophoria or aniseikonia,[16] is clinically more significant.

SUMMARY

The routine measurement of the amplitude of accommodation by the Push-Up Method and the Minus Sphere Test, as well as the use of the Dynamic Cross Cylinder Test for determining the presbyopic add are reviewed. The findings of these tests determine a tentative correction for the patient's preferred near working distance, and this is refined by the "Method of Limits" which equalizes the dioptric ranges of clear vision. This procedure effects a correction that leaves half the amplitude of accommodation in reserve.

Hofstetter's[9] survey, giving the results obtained by several clinicians using different techniques, is used to show the validity of the rule of "leaving half the amplitude in reserve." This rule and the "Method of Limits" are recommended because in directness and ease of execution they are superior to other more involved criteria and techniques.

The loss of accommodative convergence occasioned by an add for near vision necessitates increased fusional convergence. Usually this presents no problem to presbyopic patients, if they are given adequate time to make the adjustment to the new correction. Some clues are given on how to detect those patients who have difficulty in developing adequate fusional convergence.

It is emphasized that in anisometropic cases, measurement of vertical phorias, with and without glasses, is the only sure way of determining vertical imbalances at the reading level. Physiological adjustments and inherent anisophorias frequently make it unnecessary to prescribe for the differential prismatic effects of anisometropic lenses. A simple procedure for measuring the distance and near phoria is described.

In general, this brief exposition attempts to outline a simple procedure for determining near point or multifocal corrections which the average practitioner can use with full confidence in its scientific and clinical validity.

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ANNOUNCEMENT

PUBLIC INFORMATION BOOKLETS

The St. Joseph County Optometric Society has developed a series of six very well written and designed booklets dealing with optometric service to be distributed to the public by local optometric societies. These booklets are as follows: "Fine Vision Care—Its Services and Fees"; "How to Care for Your Glasses"; "The Importance of Regular, Periodic Vision Care"; "Presbyopia—Bifocals and Trifocals"; "Problems and Care of Children's Vision" and "Orthoptics—The Science of Visual Training."

Officials of local optometric societies wishing to review this excellent public relations program material should write to Dr. Bernard E. Vodnoy, Chairman, Department of Public Relations, St. Joseph County Optometric Society, 215 Poledor Bldg., South Bend, Indiana, for samples, instructions as to the use of the material, and quotations. The cost of this material in quantity, is very modest and the program has been used and shown to be most effective.

A UNIQUE CASE OF DOUBLE MONOCULAR DIPLOPIA*

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Monocular diplopia, while occurring only infrequently, is common enough to be discussed briefly in most of the textbooks dealing with binocular vision.[1] It occurs in three types of abnormal conditions: 1. Physical conditions in the eye itself such as irregular cornea, double pupil, irododialysis, dislocation or subluxation of the lens, refractive irregulartities due to incipient cataract, bubbles or transparent foreign bodies, and retinal detachment;[2, 3] 2. Simultaneous perception of normal and anomalous correspondence in squinters, sometimes referred to as binocular triplopia;[4, 5, 6, 7, 8] 3. Dissociative cerebral lesions.[9, 10] It has also been described by Werner as occurring in normal vision.[11]

Monocular diplopia arising from physical disturbances within the eye is readily understood and requires no further comment here.

The usual explanation of monocular diplopia in subjects with strabismus is some variation of the following: First anomalous correspondence developes after the inhibition of the normal correspondence between the two foveas. A new system of correspondence is set up so that an image on the fovea of the fixating eye is seen to be in the same direction from the subject as an image on an extra-foveal point in the deviating eye. This is illustrated in Figure 1. The normal path associating the two foveas, F, is blocked or inhibited as shown diagramatically at "A". A new pathway is established as shown at, "B". As long as the block occurs at, "A", an image of an object such as the triangle will be seen in the direction of the arrow, "C". Now if for any reason, the block itself becomes inhibited while the pathway "B" is still open, the triangle will be seen in the direction of the arrow "D" as well as "C". Thus the object imaged on the fovea of the deviating eye will be seen diplopically as illustrated.

The cause of monocular diplopia in dissociative cerebral lesions are too varied and too uncertain to be discussed here except to say that the diplopia is associated with calcarine lesions, gross cerebral lesions and hysteria.

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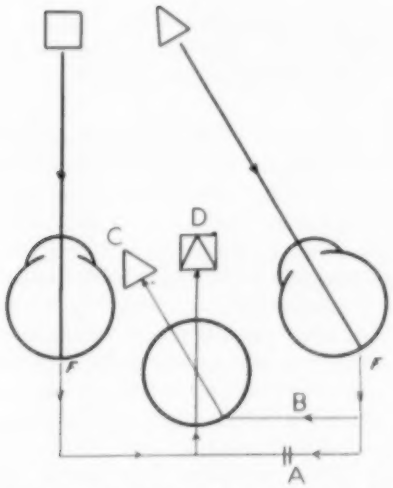

Fig. 1. Illustration of monocular diplopia in anomalous correspondence. The normal association of the foveas becomes "blocked" as illustrated at "A." The fovea in the deviating eye acquires a new local sign value so that objects imaged upon it are seen in the direction of arrow "C." Now if the "block" fails for any reason, the object imaged on the fovea of the deviating eye will be seen diplopically as illustrated.

There have been at least two reports of double monocular diplopia in the literature.[12, 13] One of these (Purdy's case) is a rather full and complete report on the investigation of the visual functions of a small angle squinter (2 arc degrees of esotropia). Originally the subject had an esotropia of 25 arc degrees. The original angle was decreased by surgery. Little is stated about the other subject except that he had amblyopia.

This is a clinical report of another subject with monocular diplopia of a unique type. Perhaps the best description of the visual responses of the patient is given by the doctor referring the patient to the School of Optometry of the University of California. His letter states in part, "Now for the symptom that is giving the patient the most trouble. If you cover one eye, and have her fixate the central target on the tangent screen, you will find the target you move in toward the center appears doubled until it is a few inches from the target she is fixating. This causes the patient to see the ears and shoulders of a person apparently doubled, when she is looking at their face."

The patient, Miss D. S., was seen in the clinic eight times between the dates of May 13, 1952, and June 4, 1953. Four of the visits were for periods approximately six hours each. The summarized data given

below will not be presented necessarily in the order in which the data was taken but an attempt will be made to group the findings into separate categories so that the results may be presented more concisely.

HISTORY

The patient, D. S., was born on March 18, 1935. Birth was difficult and her head appeared to be deformed for several weeks after birth. Her early childhood was generally normal and uneventful with the usual childhood diseases.

There was some emotional conflict within the family in as much as one parent was Catholic and the other Protestant. This disunity appeared to have its greatest effect in the realm of education. At times D. S. attended parochial schools at the insistence of the Catholic parent. This was particularly a cause for unhappiness and a source of family arguments since D. S. wanted to attend public school. It appears that this conflict within the family was a constant source of unhappiness in other ways than in the schooling of D. S.

In any event, D. S. moved out of the family as soon as she could obtain employment after graduating from high school. Good relations were maintained with her mother, at least, after she left home.

The patient has one brother who has normal vision. There are no known relatives who have strabismus or other visual defects other than ametropia.

There is some nervous and mental instability in the family since it is known that the patient's mother has been treated for schizophrenia on at least two occasions. One of these occasions was just prior to the onset of the diplopia and the other was about a year ago. It is not known whether this psychosis is related to the family religious conflict mentioned above.

When the patient was 11 years old she suddenly developed a right (?) exotropia.* In 1948 she consulted a San Francisco optometrist who apparently successfully treated the exotropia by orthoptics. Her eyes remained straight after her discharge from training.

The condition in 1948 as ascertained by telephone from the optometrist† was 14 prism diopters of exotropia combined with 4 prism diopters of right hypotropia. The subjective angle of squint was zero and the condition was diagnosed as constant concomitant exotropia

*Quote from history taken on a tape recorder:
Dr. Morgan: "Which eye turned out at the beginning?"
Mother: "I believe it was the left one, wasn't it?"
D. S.: "No, it was the right."
Mother: "Was it?"

†In spite of repeated requests no written report or additional information other than that mentioned here has been obtainable from this optometrist.

with harmonious anomalous correspondence. The patient did not have diplopia during the period that the exotropia existed.

Miss D. S. suddenly developed diplopia in October of 1951 while doing art work on a stencil over a brightly illuminated ground glass plate. The diplopia was present in either eye by itself or with both eyes opened. It was most noticeable for objects to the left of the fixation point. It was especially annoying when the patient was typing from copy. In this case the copy would appear single but she would appear to be typing on two overlapping typewriters with 20 fingers.

The family had, in the meantime, moved from the San Francisco Bay Area, but soon after the onset of the diplopia they returned to see the same optometrist whom they had seen before. He gave the patient orthoptics for a week. The diplopia disappeared during this week of training and D. S. returned home. To quote from the recorded history, D. S. speaking. "Yes, and he gave me treatments and I was over it. He got me over the doubleness and I went home and within a week and one-half or two weeks I was seeing double again. It slipped right out again whatever it was. It started again."

The patient then consulted an optometrist in her home town and he referred her to the Squint Clinic of the School of Optometry of the University of California.

REFRACTIVE DATA

Visual Acuity with old lenses: R 20/30. L 20/40
Ophthalmoscopic examination: Negative‡
Pupillary reflexes: All normal
Cover test: Slight exophoria
Versions: Normal
Convergence near point: Bridge of the nose
Static Skiametry:
R. +1.75 DS ⌒ —2.25 DC ax 7½°
L. +1.25 DS ⌒ —1.50 DC ax 175°
Subjective:
R. +1.25 DS ⌒ —2.25 DC ax 12½°
V.A. 20/25—
L. +0.75 DS ⌒ —1.50 DC ax 175°
V.A. 20/30
Heterophoria: 1△ exophoria; O hyperphoria
Accommodative amplitude: R. & L. 12.50 D.

Tests at 13 inches:
Heterophoria: 9△ exophoria; gradient 6.5△/1.00 D.

‡The patient was seen by one of the staff ophthalmologists of the School and he concurred in this negative finding

Vergences: Base-out 25△ (diplopia without blurring)
Base-in 17△ blur
Relative accommodation: Positive 3.50 D.; Negative 3.00 D.
Monocular Cross Cylinder: Add O.U. +2.00 D.
Binocular Cross Cylinder: Add O.U. +1.50 D.
Patient's old correction:
R. +1.00 DS ⌒ —1.50 DC ax 10°
L. +0.50 DS ⌒ —1.00 DC ax 168°

The patient's lenses were changed on an experimental basis to the subjective determination since this lens correction improved her visual acuity and since monocular diplopia is sometimes associated with improper astigmatic corrections. The new lenses had no effect on the diplopia but the patient claimed she was more comfortable and could see better with these lenses and so she was allowed to keep them as a permanent correction.

ROUTINE SQUINT EXAMINATION

Fixation ability: Normal right and left
Angle kappa: Right reflex centered in the pupil
Left reflex displaced +1 mm.
Estimate of the squint angle by Hirschberg: Zero
Measurement by cover:
6 meters: 16△ exophoria ⌒ 1△ right hyperphoria
40 cms.: 20△ exophoria
(Note: at times the deviation was a heterotropia rather than a heterophoria—data are maximum values found.)
Versions: Normal
Worth Four Dot:
Fuses in the light and dark from 6 feet inward
Beyond 6 feet some tendency to suppress left eye
Troposcope:
Objective angle: 12△ exophoria ⌒ 1△ right hypertropia
Subjective angle: Same
Peripheral fusion range: 7△ base-in to 9△ base-in
Central fusion range: 10△ base-in to 2△ base-out
Stereopsis: Not present when squinting but excellent when not squinting.
(Note: Again fluctuation between heterotropia and heterophoria. This probably accounts for the difference between the peripheral and central fusion range.)
After-image: Normal cross
General remarks: On questioning it was found that D. S. could

let her eyes deviate into the exotropic position at will. She stated that she was aware of the position of her eyes at all times. This was found to be true at all subsequent examinations. At odd times she was asked to state whether her eyes were straight or deviating. She always answered correctly without hesitation. She was also asked either to "make her eyes straight or deviated" as the case might be. This she was also able to do without trouble. D. S. stated that her eyes were straight most of the time. Her mother concurred, stating that she had not noticed her daughter's eyes deviating for the last several years.

The diplopia was not present during the Troposcope examination when the targets used were smaller than 3° subtense but it was present for the edges of targets larger than 5° subtense. The angular separation of the diplopic images was much less than the deviation of the eyes.

Diagnosis:

Intermittent exotropia (rarely squints) with normal correspondence.

Deviation concomitant.

TESTS TO CHECK ON OPTICAL EXPLANATION FOR THE DIPLOPIA

Check with the Pin Hole Disc: One eye was occluded. A pin hole disc of 1.5 mm. was placed before the pupil of the other eye and moved from place to place so that different areas of the cornea and lens were used in the image formation. This test proved to be entirely negative. Both the "real" and the "ghost" image appeared to be less intense with the pin hole disc in place; however, the relative intensity, spacing and reality of both images did not change perceptibly with a change in position of the pin hole. The same results were obtained for each eye in turn.

Check with Stenopaic Slit: A stenopaic slit with a width of 1 mm. was placed before one eye with the other eye occluded. There was no change in the diplopia as the slit was moved up and down, side to side, or obliquely or when the slit was rotated. The same results were obtained for each eye in turn.

Check with Knife Edge Occluder: One eye was occluded. The other eye was occluded gradually with a straight edge occluder. As long as vision was possible, both images were present regardless of how much of the pupillary aperture was occluded or from which direction the occluder was moved.

Ophthalmometer: The cornea was toric as one would suspect from the astigmatism. The curvature was found to be regular.

Results and Conclusions: It seems apparent that there can be no optical explanation for the diplopia.

INVESTIGATION OF REGION OF DIPLOPIA AND SINGLENESS

D. S. did not see the object of regard as double. All other objects were reported as being seen diplopically. The intensity of the false or ghost image was not uniform throughout the field of vision but was more intense to the left. It was found that both the area of singleness and the area of most intense diplopia could be plotted on a tangent screen. The results of one set of these measurements are shown in Figure 2 for a 3 mm. test object at a test distance of one meter.

The patient showed marked consistency in being able to repeat these findings on subsequent testing. The testing was carried out at several distances varying from 18 inches up to 8 feet. The angular subtense and location of these areas was maintained relatively constant for all testing distances and for all testing methods. Variations in the testing method and distance were introduced to check on the angular constancy in the hope that some knowledge might be gained as to whether these field defects could be explained on the basis of hysteria in which case, one might suppose that the physical size rather than the angular size of the changes would remain constant.

D. S. reported, when the test object was moved from the area of very apparent diplopia away from the fixation point, that the ghost or false image faded materially but it did not fade entirely. When the test object was moved toward the fixation point, the ghost image suddenly disappeared.

It should be noted that the area of singleness is similar in size and shape but the area of marked diplopia is considerably larger in the right eye. The location of this area is not exactly the same in the two eyes but in each instance it is in the right half of each retina and represented in the right hemisphere. The center of this area in the right eye is 8 degrees from the center of the fovea and in the left eye about 5.5 degrees from the center.

The area in the temple retina of the right eye would be the area receiving the image of a fixated object if a right exotropia existed. It should be noted that 8 degrees is almost exactly 14 prism diopoters. This equivalence would not exist if there was left exotropia.

AFTER IMAGE RESULTS

The right eye was occluded and D. S. fixated with her left eye a red spot in the center of a dark area placed in the center of a line filament light oriented horizontally. Exposure was for approximately 15 seconds. The occluder was moved to the left eye and the line filament was placed vertically. Exposure was for about 10 seconds. D. S. then reported that the after images of the light formed a perfect cross.

During the examination it had been discovered, as previously mentioned, that she could willfully become a divergent squinter. Consequently, the after images were re-enforced and she was instructed to turn her right eye out. Under these circumstances she reported a non-cross after image with the vertical streak to the right of the horizontal.

Next, the after-image filament was imaged in the temple retina of the right eye by having D. S. fixate 8 degrees to the right of the vertical streak. The after image in the left eye was created in the normal way. Now she reported two sets of two vertical images, one set making a cross with the horizontal image and the other set appearing to the left of the center. The vertical images consisted of one "real" image and one "ghost" image.

Eccentrically placed after-images were created in other regions of the retina. These images were double but only one set existed. The location of this set was normal when she was not squinting and anomalous when she was squinting. The appearance of two sets of after images was reported only when the after image was created in the right temporal retina approximately 8 degrees from the point of fixation.

These results indicate that sometimes D. S. has normal correspondence but that when she is squinting she has anomalous correspondence. It is also apparent that under certain conditions she has the usual monocular diplopia of squinters with anomalous correspondence—really it is monocular quadroplopia.

ANGULAR SEPARATION OF THE DIPLOPIC IMAGES

Many measurements of the angular separation of the diplopic images were made. Only one of the methods used will be discussed in detail.

This method separated the two eyes by the use of red-green spectacles and anaglyphic drawings as shown in the upper part of Figure 3.

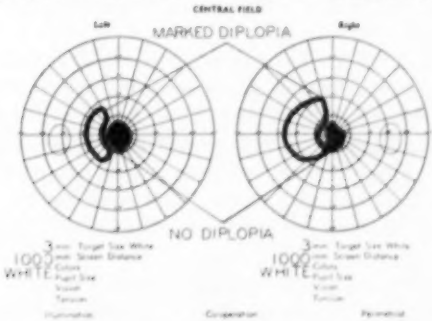

Fig. 2. Area of singleness and marked diplopia are shown as measured on May 14, 1952.

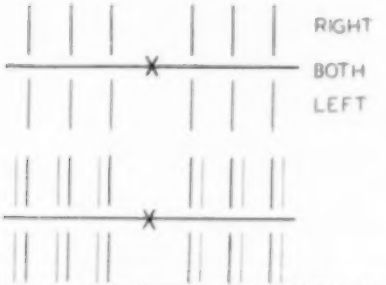

Fig. 3. The target used to note the location of the diplopic images is shown in the upper part of this figure. The upper lines were red and visible only to the right eye. The lower lines were blue and visible only to the left eye. The heavy horizontal line with the X were black and visible to both eyes. The report of the target appearance is shown in the lower part of the figure. The heavy lines represent the real images; while the light lines represent the ghost images.

The upper vertical lines were visible only to the right eye while the lower lines were visible to the left. The central portion consisting of the horizontal line and the X was visible to both eyes and was used to hold fusion. The subject was instructed to fixate the X.

D. S. reported that she saw each of the vertical lines, both below and above the horizontal line, double; there was one "real" line and one "ghost" line making up each pair. The real lines remained lined up with each other as the figure was drawn. The ghost lines were also lined up with each other. The appearance of the figure as reported by the subject is shown in the lower half of Figure 3.

This indicates that the diplopia was the same in both eyes. The double monocular diplopia resulted in only binocular diplopia because the right and left real images fused with each other and the right and left ghost images fused.

Measurements of the angular separation of the real and ghost images were made by moving one of the lines as a fiduciary mark. Objects were placed above and below the horizontal as already described. Each of these objects was seen double with the real images and the ghost images in vertical alignment. One of the real images, the upper for example, was moved side ways until it was in line with the lower ghost image corresponding to it. The amount that this object had to be moved then represents the separation of the real and the ghost image. The process was reversed from time to time to make the upper ghost line up with the lower real image.

Measurements were made with the right eye fixating (left occluded), with the left eye fixating, and with binocular fixation. In the nasal field of each eye measurements were attempted at 3.5°, 7.5°

and 11° from the fixation point. In the temporal field measurements were attempted at 3.5°, 7.5°, 11°, and 15° from the fixation point.

No measurements were possible monocularly at the 15° position in the temporal field. These objects were, of course, imaged on the blind spot. The attempt to make these measurements was made as a matter of routine in order to see if D. S. would give proper responses. She always reported that no objects were visible to her in this portion of the visual field.

The results of one set of measurements are shown in Table 1. The observation distance was 1 meter. The movement of the fiduciary mark is given in centimeters.

TABLE 1

Location	Right Eye Temp. Field	Left Eye Nasal Field	Both Eyes Rt. Field	Average
3.5°	1.7	1.6	1.9	1.7
7.5°	2.3	1.7	2.3	2.1
11°	2.3	2.1	2.2	2.2
	Nasal Field	Temp. Field	Left Field	
3.5°	1.3	1.7	1.3	1.4
7.5°	1.0	1.6	1.5	1.4
11°	1.3	not possible	1.8	1.6
Average	1.7	1.7	1.9	1.8

The data shown in Table 1 can be converted into tangents of angles by dividing by 100. It can thus be seen that angles varying from 35 minutes to 1 degree 36 minutes were found with the mean measurement being about 1 degree 2 minutes. The variation for the mean of six sets of measurements was from 59′ to 1°4′. These measurements were made at observation distances of 20 cms., 81 cms., 1 meter, 2 meters and 2.5 meters. The mean of some 150 measurements at all distances was 1°2.5′ with a standard deviation of ±7′.

MEASUREMENTS OF MAXWELL'S SPOT (R.D.P.)

It has been determined that Maxwell's spot can be used to determine the accuracy of central fixation and the degree of eccentric fixation.[14, 15] The entoptic observation of Maxwell's spot or the R.D.P. of Walls and Mathews[16] was made possible by viewing an opal glass screen illuminated by two 200 watt Skan Projectors. One projector contained in the slide holder experimental Wratten filter #2389 while the other contained Wratten #96 (neutral). The light from each projector was interrupted alternately by an episcotister mounted before the projectors. The flash rate was varied until the entoptic image was easily seen. The observation distance was 2 meters.

D. S. fixated a small spot on the screen. Black lines were then moved across the screen and placed tangent to the edges of Maxwell's

spot right and left and up and down. The center of the perceived spot was calculated with respect to the right and left borders and with respect to the upper and lower borders. The departure of the fixated spot from the center of the R.D.P. was then calculated. There was no vertical displacement. The horizontal displacements are shown in Table 2 which is a frequency table of the number of times a particular variation was found.

TABLE 2

Departure in Centimeters	Left Eye Trials	Right Eye Trials
0.00-0.09	1 Nasal	3 Temporal
0.10-0.19	1	1
0.20-0.29	3	2
0.30-0.39	0	1
0.40-0.49	2	2
0.50-0.59	2	0
0.60-0.69	0	1
0.70-0.79	0	1
0.80-0.89	2	0
0.90-0.99	1	0

The angle of eccentric fixation was, on the average, 8 minutes of arc for the left eye and the fixation center was always in the nasal retina. The average for the right was 6 minutes with the center always in the temporal retina.

It will be noted from Table 2 that there was some considerable variation in the degree of eccentricity. The only constancy was the continued use of the same half retina so that the fixated spot was represented in the right hemisphere.

COLOR FUSION

For this series of experiments, pairs of 3 millimeter round pieces of Munsell papers were used in two series. One series was the Munsell "Maximum Color" papers: namely, 5 R 4/14, 5 YR 6/12, 5 Y 9/14, 5 GY 7/10, 5 G 5/8, 5 BG 4/7, 5 B 4/8, 5 PB 3/12, 5 P 4/12, and 5 RP 4/12. This series of colors will be referred to as the "saturated colors." The other series was made from the same hues but the V/C value for all of these papers was 6/6. This series will be referred to as the "desaturated colors."

The colored discs were placed on a neutral grey paper which had a fixation mark drawn upon it. One disc was placed 4 degrees to the left of the fixation mark while the other was placed slightly over 5 degrees to the left of the mark. In this way, the real image of the most distal spot coincided with the ghost image of the proximal spot. The results of some of the various combinations tried are given below. It was

found that best results could be obtained with the right eye, the left being occluded.

Papers used:	Subject's report of the appearance of the middle fused spot:
1. Saturated R & BG	1. Appears predominantly red.
2. Saturated R & R	2. Middle spot brighter and redder than the other two.
3. Saturated RP & YR	3. "Mossy"—dark, no particular color. When forced to name color, she stated it is probably a dark violet.
4. Saturated B & YR	4. Rivalry. Occasionally spot is greenish blue. Dimmer than other two.
5. Desaturated B & YR	5. Whitish tan color—definite and bright. When background changed to white, spot becomes darker. Eventually decides best description is "dirty white."

In every case, except one, the ghost or anomalous image appeared to fuse with the real image. The only time rivalry resulted was when the saturated blue and yellow-red papers were presented. The so-called Henning[17] effect (in which two different colored objects appear to occupy the same place at the same time) as described by Purdy[12] for his subject was absent under the conditions used. Miss D. S. behaved more like the subject described by Bielschowsky[4] in that the middle fused spot was definite and of a single real color.

The Henning effect can be appreciated by normal subjects under very special circumstances. If two line drawings which are slightly disparate are prepared, one in one color and the other in another color, and these drawings are viewed in a stereoscope so that they fuse; a single drawing will be seen which at times will appear outlined in the two colors simultaneously. The figures must be small enough to be viewed as a whole without eye movement.

Special targets were prepared for D. S. and placed in a stereoscope. In one position the real image for the right eye was made to fuse with the real image for the left eye. This meant that the two anomalous images were also fused. She reported that at times both colors were present in both images simultaneously. When one anomalous image was fused with one of the real images, the center or "fused" image also exhibited the Henning effect at times.

MEASUREMENT OF STEREOPSIS

When D. S. was presented stereometric patterns in which the two real images fused with central fixation (no diplopia) she was able to pass all the tests for stereopsis which were used. These consisted of the Verhoeff Test, the D. B. 6 card and the S. M. series (cards DC 1 to DC 23) of the Keystone View Co., and other stereo charts for the Troposcope and the Synoptophore.

When eccentric fixation was used so that the diplopia became manifest for the targets, and the targets properly positioned, D. S. reported that she was not able to state whether the fused middle picture (one

Fig. 4. The appearance of a room to the subject while she was maintaining steady fixation upon the X using only her right eye.

real and one ghost) was depthy or not. This inability to make the proper judgment was present when the real images fused, when the ghost images fused, or when a real image fused with a ghost image.

It was thought that this uncertainty might be overcome if single line images were presented which would not be greatly effected by the poor resolving power of the periphery of the retina. Special targets were made for this purpose of varying degrees of disparity. Again D. S. expressed great uncertainty as to whether there was any depth in the situation. When forced to state whether the perception was flat or depthy, she stated it was flat.

BREADTH OF FUSION ZONE

It is well known that normally in binocular vision slightly disparate images will fuse. It is also known that there are limits to this lack of exact congruence for fusion. In many of the tests utilized, such as for color fusion and for stereopsis, it was possible to note the preciseness with which the objects had to be located in order to have one real image fuse with one ghose image.

It was found, for example, that the placement of objects 3.5° from the point of fixation had to be precise within the limits of about ±7 minutes of arc. At 7.5° from the point of fixation the allowable error of placement of one of the objects increased to about ±13 minutes of arc. In the measurement of stereopsis, the actual disparity which

Fig. 5. The same as figure 4 except the left eye was used.

could exist with the report of singleness was approximately the same.

This variation in placement of one object while maintaining singleness simulates the normal binocular Panum area phenomenon. It is interesting to note that the amount of error allowable in the case of D. S. is approximately 3% of the peripheral angle. This is the same as the normally accepted horizontal size of Panum's areas.

FIGURE DRAWING

Miss D. S. was requested to prepare two drawings of a room at home under conditions of constant fixation. She was instructed not to move her eyes and to indicate on the drawing the fixation point. One was to be drawn with the left eye occluded and the other with the right occluded. Tracings of these drawings are shown in Figure 4 and Figure 5. Tracings are used for purposes of reproduction since the originals were made in crayon without sharp lines.

If these drawings are inspected carefully, it will be noticed that in nearly every case only the distal borders of objects are shown double. In other words, there appears to be no false border on the solid part of the objects, such as on the drape. Some portion of the false and true images should overlap when the object is of any size; clearly this does not seem to be the case. This is similar to patient J. P. F. described by Bender[9] who drew only half of geometric figures. Bender assumed that the Gestalt of the closed figure prevented this subject from "seeing"

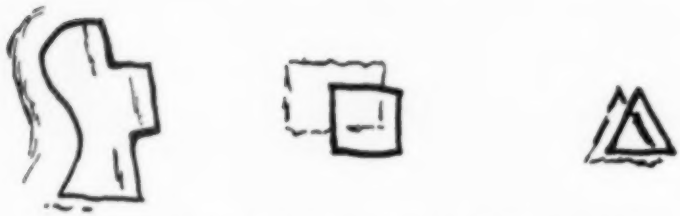

Fig. 6. Tracings of the ghost images associated with closed figures.

the ghost image where the real figure was. In other words, the figure could be thought of as hiding the ghost—one cannot see through a solid.

Outline drawings were then prepared for D. S. and she was asked to draw in the ghost. Tracings of these drawings are shown in Figure 6. It will be noticed that closed simple figures as used in Figure 6 did not prevent the perception of the ghost images appear slightly larger and somewhat elevated. This can also be seen in Figures 4 and 5.

D. S. was asked whether the ghost images appeared behind or in front of the real images. She stated that the two images appeared in the same plane. She was then asked whether she interpreted the drawings used in Figure 5 as representing solids or mere outlines. She stated that she thought these drawings were merely outlines and hence transparent. She was also questioned as to why she thought the proximal borders of real objects did not appear double. After some concentration and apparent introspection, she stated that she supposed it was because this edge "blended" into the real figure.

TACHISTOSCOPIC PRESENTATIONS

Targets were presented tachistoscopically by projection in the region in which the diplopia was most obvious: namely, 8 degrees to the left of fixation. The targets were exposed for 1/100, 1/50, 1/25, 1/5, and 1/2 seconds. The diplopia was apparent when the exposure time was 1/25 second or longer.

This could be due to the reduction in the stimulus value as well as to the speed of stimulation. In order to test this, the projection distances were altered but the observation distance was held constant. The test was repeated for several distances. In each case the results were identical.

It thus appears that the diplopia takes time in order to become manifest.

DISCUSSION

The after-image observations indicate that the two foveas are

normally corresponding, but that when the eyes deviate and the exotropia becomes manifest, anomalous correspondence exists. When the after-image was created eccentrically, the correspondence appeared both normal and anomalous simultaneously. Thus one may conclude that the anomalous correspondence has not been entirely eliminated in spite of the fact that D. S. normally does not have strabismus.

It is interesting to note that if one believes the history to be correct, the squint did not become apparent until D. S. was 11 years of age. Two years after the onset of the squint she was found to have anomalous correspondence. It is generally assumed that anomalous correspondence is an adaptation to a squint and that it is present only when the squint develops early in life and exists for some time. Here one must consider either that the history is not correct and the squint existed as an intermittent exotropia before it became constant or that the usual theory for the development of anomalous correspondence is not correct.

The diplopia that is present does not seem to be directly related to the anomalous correspondence since the angular magnitudes are greatly different and since there is no diplopia in the central region of the field of vision. The area of marked diplopia appears to be associated with the previous exotropia solely on the basis of the similarity in location. The area of maximum diplopia in the right eye would be the area receiving the image of the fixated object if a right exotropia existed. The fact that this area is in the same relative position for the left eye may be taken as evidence for the innateness of normal correspondence.

Except for the apparent absence of stereopsis, D. S. gave responses similar to those of binocular vision even though both "fused" images were presented to only one eye. There was apparently fusion in the sense of singleness, color fusion, and Panum area phenomena. This means that any general theory of fusion and singleness must account for the possibility of "corresponding points" existing in only one eye.

If the diplopia is due to some lesion, the lesion must be located posterior to the chiasm since the defect is homonymous. The effect is not unlike lesions in the area striata since there is sparing of the macula as well. The RDP measurements indicate that there is a very slight degree of eccentric fixation such as that which accompanies hemianopia or hemiamblyopia.

The similarity of this condition to hemiamblyopia can be seen by quoting from Duke-Elder's[19] description of the disturbances in spatial perception associated with hemiamblyopia.

"This 'pseudo fovea' is always close to the old fovea and it is not precisely located in objective space but changes its position with the size of the object at which the patient is looking. In hemiamblyopia, objects presented to the amblyopic fields appear displaced towards the fixation point; a new functional centre is displaced towards the

blind side, so that objects falling in the amblyopic fields are seen displaced towards the seeing side. This phenomenon is seen essentially when the eyes are employed in ordinary inspection. When the gaze is attentively fixed on a determined object, the old fixation point is used, so that the 'pseudo-fovea' is not usually evident in perimetry. But its functional presence is seen in the past pointing and failure to grasp an object accurately, signs exhibited by the usual patient suffering from recent hemianopia.

"This shift of spatial value may be incomplete so that two sets, the normal and the pathological, may exist side by side. The consequence is that, as is frequently demonstrable in squinting cases, *double vision of central origin* may occur owing to the temporary acquirement of a double spatial value in the damaged cortex."

If eccentric fixation exists the subject might well act as though this were the "straight ahead" position. Each peripheral retinal point might, at the same time, maintain its true local sign as well as its newly acquired one. Thus peripheral objects would appear in two separate directions from the observer simultaneously, in other words diplopia would exist. If the factor causing this were some disturbance in the occipital cortex, there might well be sparing of the macula. The main difficulties with this theory as applied to the case of D. S. are that the magnitudes of eccentric fixation and the angular separation of the images are vastly different; and the fact that the false image is to the left in the left half of the visual field and to the right in the right half of the visual field.

If it can be said that the cause of the spatial disturbances in hemianopia and hemiamblyopia is the poor vision in a half retina, then perhaps the disturbance in the case of D. S. is an outgrowth of the suppression which previously existed when she was exotropic.

Psychic disturbances as a basic cause for the diplopia cannot be overlooked in this case, particularly in view of the disturbing home life and the known psychosis in the family.

Most of the measurements made would seem to rule out hysteria since the common responses of impossible situations did not exist. Blind spot phenomena were always correctly reported. The angular separation of the diplopic images rather than the physical separation remained constant. D. S. did not use the defect as an excuse for poor performance or as an excuse to avoid something. On the whole, D. S. appeared and acted like a normal young lady with exceptional powers of observation.

It should be noted that the original strabismus and the diplopia which occurred at a subsequent date had a sudden onset. As a matter of fact, the onset of the diplopia was noted at a specific time on a certain date. Generally speaking, clinicians tend to regard phenomena which have a dramatic sudden onset as being due to some physical event, such as a hemorrhage for example. This is particularly true when the recovery is gradual. In the case of D. S., this would tend to rule out the idea that the diplopia was a development growing out of the eccentric fixation or the anomalous correspondence or both. The suddenness of the onset

would lend credence to the theory that some occipital disturbance, either physical or psychic, brought on the diplopia. It seems most logical to assume here that some vascular disturbance was the fundamental cause of the various phenomenons reported here.

After the third visit, Miss D. S. was advised to return home and to discontinue orthoptics. She was also advised to learn to type with the typewriter to the right rather than to the left of the copy. She was purposely given to understand that while her case was unusual, it was not without solution. She was instructed to make a positive effort not to see or to look for the diplopia.

Between her third and fourth visits to the clinic, it is known that she consulted an ophthalmologist, a psychiatrist and a neurologist. As near as can be determined, the results of these examinations were negative.

Miss D. S. reported at her last visit to the clinic that the diplopia had almost entirely disappeared and that normally she was no longer aware of it. Attempts to measure the angular separation of the images were not successful because of the fading out of the ghost image. Only very strong stimuli such as a light would elicit the diplopia long enough for her to be sure that it was present.

The author wishes to acknowledge the helpful assistance of Dr. Merton C. Flom of the School of Optometry in making many of the measurements discussed in this paper. Dr. Gordon Heath also assisted in making some of the measurements.

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A SIMPLE PHOTOGRAPHIC METHOD FOR CONTINUOUSLY RECORDING VERTICAL AND HORIZONTAL EYE MOVEMENTS*

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This is a report of the principles and application of a new eye movement camera designed to record continuously all ordinary eye movements which a person makes in the use of his eyes. Such a camera for continuously recording the details of the eye movements made over an unlimited length of time should be valuable in pure and applied visual research.

At the present time there are three general techniques for making photographic recordings of vertical and horizontal eye movements. The following brief discussion of these methods is presented to show their uses and limitations.

In 1902 Stratton[1, 2] used a stationary film camera, set for a time exposure, to record the various positions that the eye took as it fixated various parts of a visual task. Because the entire film was exposed, records of eye movements for any extended period of time were not possible, and due to the overlapping of the traces made as the eye moved about, the records were frequently difficult to interpret. This method, however, has proven quite valuable in research, particularly in the field of advertising.

Judd[3] in 1905 introduced the study of eye movements by motion picture photography. While long records of both vertical and horizontal eye movements were easily possible, the technique could not record fine ocular movements. The motion picture camera however is the solution to certain difficult recording situations as shown by Fitts *et al*[4] (1950). They applied it in the study of the pilot's eye movements across the instrument panel of an aircraft in flight.

The technique of Dodge and Cline[5] (1901) was used in the design of the ophthalmograph which records only the horizontal component of an eye movement. It was modified by Ratliff and Riggs[6]

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The camera reported herein was designed and built by the author at the Ohio State University under a Research Foundation contract with the Timken Roller Bearing Company.

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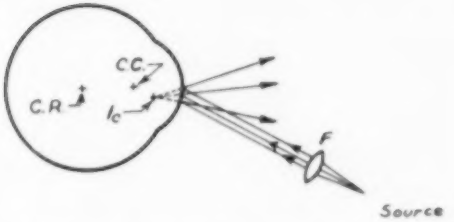

Fig. 1. Diagram of the image produced by reflection at the cornea. C. R. is the center of rotation of the eye; C. C. is the center of curvature of the cornea; I_C is the image produced by reflection at the cornea of light from a distant point source; F is a collimating lens.

(1950) into a continuous recording device of high sensitivity. They used a pair of dove prisms and converted the vertical component of an eye movement into an equivalent horizontal movement which was photographically recorded along with the horizontal component of the movement of the same eye. While Riggs' equipment gives a precise record of even the finest eye movements it does not have general use-

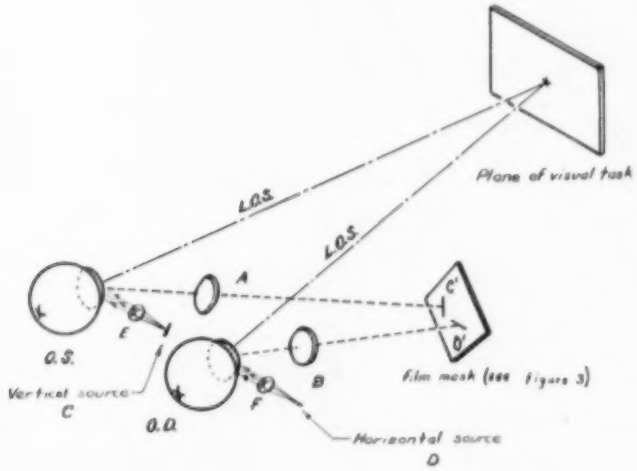

Fig. 2. Schematic drawing of optics involved in vertical-horizontal components camera.

A, B, the left and right camera lenses respectively (in actual practice a minus cylinder was added to make image lines C′ and D′ longer);
C, D, the vertical and horizontal line filaments respectively;
E, F, the left and right collimating lenses respectively, and
C′, D′, the images produced by camera lenses A and B from the corneal reflexes of the left and right eyes.

fulness because of complex optics and the limited illumination efficiency of the optical system.

The land marks on the eye suitable for photographic recording of its movements are few, and in some instances photographic reference points have been added to the eye so that a better record could be obtained.[3] One very useful feature of the normal eye is the reflection from the front surface of the cornea which will form an image of a distant point object as shown in Figure 1. Since the center of the corneal curvature C.C. is anterior to the center of rotation C.R. of the eye, the corneal image I_c will move with the cornea when the eye rotates. This corneal "reflex" is used in the photographic technique described in this paper.

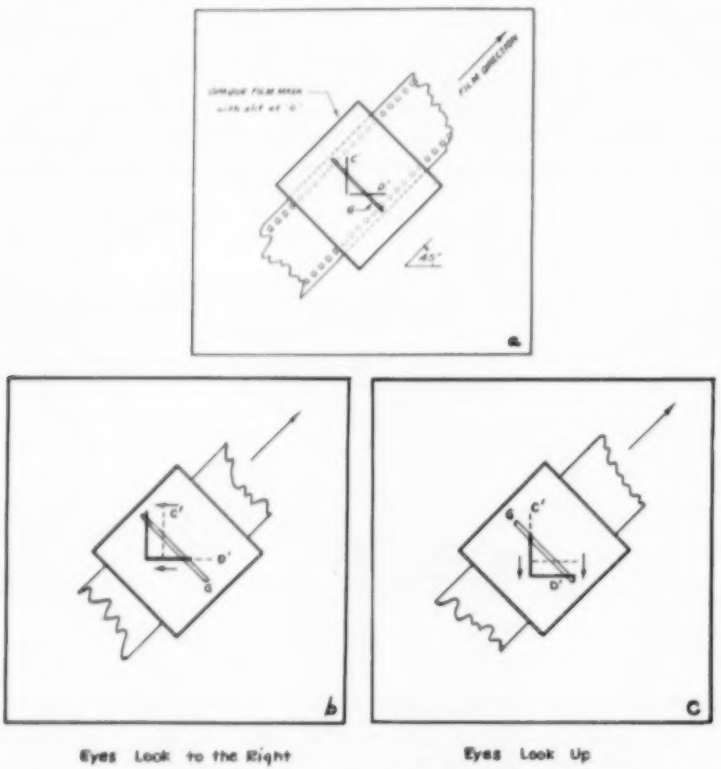

Fig. 3a,b,c. Detail of film plane. C', image of bright corneal reflex from the left eye; D', image of bright corneal reflex from right eye; G, slit in opaque screen (only the light that penetrates the slit may affect the film).

It was also used by Stratton and by Dodge and Cline in the techniques described above.

Figure 2 is a diagram of the optics of the camera and light sources used for resolving eye movements into vertical and horizontal components and recording these components. In Figure 3a, the slit shown at 135° is placed before a film traveling continuously in the 45° meridian. Falling upon this slit is a vertical line image, C′, of the corneal reflex of the one eye (see Figure 2) and a horizontal line image, D′, from the corneal reflex of the other eye. These images move opposite to the motion of the eyes due to optical inversion by lenses A and B.

The slit, coupled with the orientation of the two line images, serves to analyse the movement of these images into their horizontal and vertical components. If we imagine that the eyes are rotated to the right, then both the vertical and horizontal line images would move to the left (Figure 3b). The relative motion of the horizontal line image along the slit would be zero, but the relative motion of the vertical line image across the slit exposing the film would be 1.4 times as much as the original horizontal movement of the images. This is true since the hypotenuse is 1.4 times the length of either leg of a 45° triangle. C′ and D′ represent the two legs, and the slit, G, the hypotenuse of a 45° triangle.

Similarly, if we should move the eyes upward, the vertical and horizontal line images would move downward (Figure 3c). The relative motion of the vertical line image along the slit would be zero, whereas the relative motion of the horizontal line image across the slit would be 1.4 times the original downward movement of the images. Therefore, the vertical line image will record horizontal movements of the eyes and the horizontal line image will record vertical movements of the eyes when they fall on a 45° slit before the film.

The use of one eye as an indicator of vertical eye movements and the other eye as an indicator of horizontal eye movements is satisfactory, provided fusion, ductions and phorias are normal, and the visual task is close to a single plane. However, a modification in the optics would make it possible to record both the horizontal and vertical components of the movements of each eye simultaneously. This would give complete freedom to the type of visual task which a pair of eyes could perform and yet have their movements recorded. This also would make the technique useful in evaluating the effects of abnormal phorias and ductions as well as other factors influencing behavior of the eyes in a given visual task.

To incorporate the principal outlined above, an ophthalmograph

of early design was modified by an increase in the aperture of the objective lenses, the addition of a minus cylinder to each objective and the addition of a slit before the film at right angles to the motion of the film. The front portion of the ophthalmograph which supports the objective lenses was detached from the part containing the film mechanism and the parts were reassembled so that the film mechanism was rotated 45° about a line perpendicular to the film plane. The instrument so modified provided a film moving at 45° as shown in Figure 3a.

A line filament source such as is used in streak retinoscopes was used to illuminate each cornea. The source for each eye was oriented so that it corresponded with the astigmatic image falling on the film plane. Figure 4 shows the method of mounting the ophthalmograph so that it provided a minimum of interference in the field of view of the subject.

Fig. 4. Sketch of actual application of vertical and horizontal eye movement camera in industry.

The method and general arrangement of equipment described in this paper have been used in a study by the author of the eye movements performed by roller inspectors at the Timken Roller Bearing Company in Columbus, Ohio and in Canton, Ohio. Records were taken while up to 600 rollers were given a routine visual inspection. The technique could be applied to studies of other industrial visual tasks or to research on reading, advertising, or highway vision.

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ANNOUNCEMENT

AMERICAN OPTOMETRIC FOUNDATION

Upon the recommendation of the Advisory Research Council to the American Optometric Foundation, the following has been adopted by the Foundation Directors:

The Foundation has established a series of Research Awards, to be awarded to that undergraduate optometric student at each accredited school or college conducting during the school year the most outstanding piece of laboratory experimentation or research work, to be judged by a faculty committee to be appointed at each of the participating schools.

The American Optometric Foundation announces an Annual Award to that practicing optometrist in the United States who has submitted to the Foundation a report of the most outstanding Research Paper published in the regular scientific publications during the year, to be judged by a committee selected by the Foundation.

It is hoped that many practicing optometrists will enter this contest. All such reports and correspondence about this award should be addressed to the President of the Foundation, Dr. William C. Ezell, 208 Andrews Building, Spartanburg, South Carolina.

AN ILLUSRATIVE CASE ANALYSIS INVOLVING ACCOMMODATION AND CONVERGENCE FINDINGS*

H. W. Hofstetter†
Indiana University, Division of Optometry
Bloomington, Indiana

The case presented here was selected from the files of an optometry clinic to illustrate the application of certain established procedures[1] in the analysis of accommodation and convergence findings, and in the derivation of a prescription in accordance with these procedures. Only the clinical findings that relate directly to accommodation and convergence are included in this report. So far as could be ascertained in this case the findings which have been omitted had no bearing on the patient's expressed needs or visual problems. The information used in this analysis was recorded essentially as follows:

Patient: Female, age 30.

Occupation: Small parts inspector. Continuous visual work at 12" or 13". Visual tasks outside of job are not severe.

Previous Rx: +0.50D. O.U. Prefers not to wear glasses, but wears them at work.

Symptoms: Unable to describe symptoms accurately, but reports various symptoms thought to be "eyestrain," and associates these definitely with her work. Present glasses give some relief. Reports that the present glasses definitely give relief from "eyestrain" at movies.

P. D. = 56 mm.

Retinoscope: +0.50 D. O.U.

Subjective: +0.50 D. O.U.

Phoria at 6 M. through subjective = ortho.

Phoria at 40 cm. through subjective = 4Δ eso.

Phoria at 40 cm. through + 1.00⌒ subjective = 4Δ exo.

Base-in limit** at 6 M. through subjective = 8Δ.

Base-in limit at 40 cm. through subjective = 5Δ.

Base-out limit at 6 M. through subjective = 10Δ.

Base-out limit at 40 cm. through subjective = 21Δ.

Binocular minus-lens limit @ 40 cm. = —.75⌒ subjective.

*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 12, 1954. For publication in the February, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Ph.D., Director of Division, Fellow, American Academy of Optometry.

**The "limit" may represent either a *blur* or a *break*, whichever occurred first.

Binocular plus-lens limit @ 40 cm. = +2.25⌒ subjective.
Amplitude of accommodation (monocular push-up) = 9.00 D.
P. P. of convergence = 4.0 cm. from spectacle plane.

These data are plotted on an accommodation-convergence graph in Figure 1.

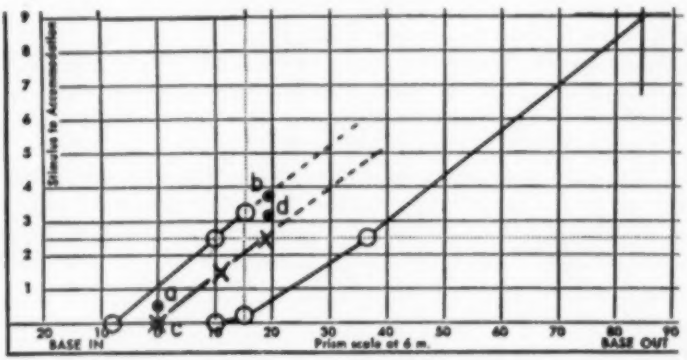

Fig. 1. A Plot of Accommodation and Convergence Findings. The circles represent limits of clear single binocular vision. The X's represent phorias. The heavy dots labeled *a*, *b*, *c*, and *d* represent demand points referred to in the discussion. The heavy vertical line and heavy horizontal line in the upper right hand corner represent the maximum convergence and accommodation respectively.

Inspection of the graph discloses reasonably normal accommodation ability for the age, reasonably normal positive and negative fusional convergence, a normal phoria at distance, but an unusually high ACA ratio. The fact that there is substantial parallelism between the line connecting the base-in and minus-lens limits, the phoria line, and the line connecting the base-out and plus-lens limits indicates good reliability and validity of the individual findings. The fact that the base-out and plus-lens line connects without major deviation with the point of maximum accommodation and maximum convergence also indicates a rather high reliability and validity of the related findings.

Both Sheard's and Percival's criteria of comfort were applied in the present analysis to determine what discomfort might be predicted (a) at distance without glasses, (b) at near without glasses, (c) at distance with the previous glasses, and (d) at near with the previous glasses. Further, the same criteria were employed to select the prescription which would be expected to eliminate discomfort (e) at distance, and (f) at near.

(a) The point *a* on the graph represents the stimulus demand to accommodation and convergence when the patient is viewing a distant

object without glasses. From the graph it may be seen that for this condition the phoria is approximately 3½ Δ eso, the base-in limit is approximately 3Δ, and the base-out limit is approximately 19Δ. This means that neither Sheard's nor Percival's criterion is met without glasses.

(b) The point *b* on the graph represents the stimulus demand to accommodation and convergence when the patient is viewing an object at 12.5" without glasses. From the graph it may be seen that for this condition the phoria is approximately 10Δ eso, the base-in limit is practically zero, and the base-out limit is approximately 27Δ. Again neither Sheard's nor Percival's criterion is met without glasses. In fact, the demand is right at the limit of clear single binocular vision.

(c) The point *c* on the graph represents the stimulus demands when the patient is viewing a distant object with the previous glasses. Here the phoria is ortho, the base-in limit is 8Δ, and the base-out limit is approximately 10Δ. Under these conditions both Sheard's and Percival's criteria are satisfactorily met.

(d) The point *d* on the graph represents the stimulus demands when the patient is viewing an object at 12.5" with the previous glasses. Here the phoria is 5Δ eso, the base-in limit is approximately 5Δ, and the base-out limit is approximately 22Δ. Neither Sheard's nor Percival's criterion is fully met, though the requirements are much less severe than in condition (b) above.

(e) It is apparent from (c) above that the previous glasses need not be altered to give comfort at distance. Any increase in plus correction would produce a blur without improving the balance of base-in and base-out limits. A decrease in plus correction of more than about .37D would be contra-indicated by both criteria. Since the refractive findings showed +0.50 D., at least a part of that should be prescribed for best distance seeing; i.e., for such activities as watching movies or driving an automobile. It must, of course, be realized, also, that discomfort can be eliminated by the patient herself without glasses if she simply lets the accommodation relax and tolerates a small degree of blurredness, as may well occurr in casual activities not requiring critical vision.

(f) To provide a more comfortable balance at 12.5" the stimulus to accommodation may be reduced. Sheard's criterion would require an addition of at least +0.37 D. to the refraction findings. This would give a phoria of 3Δ eso, and a base-in limit or "reserve" of 6Δ. Percival's criterion would require an addition of +0.62 D. to the refractive findings, giving a base-in limit of 9Δ and a base-out limit of 18Δ.

The amount finally decided upon for a prescription was a com-

promise of +0.50 D. added to the refractive findings for use at near. This compromise consisted of a pair of +1.00 D. spheres for vocational and reading glasses, with the previous glasses to be worn for distance. A short time later a pair of sunglasses was requested. To allow for the dioptric difference between the 6 M. testing distance and the greater distances to be viewed out-of-doors, the sunglass correction was made up in +0.25 D. spheres, a reduction permissible under (e) above.

A limited examination given at the time the sunglasses were prescribed and a repeat examination about a year later showed no changes. The prescriptions were reported completely satisfactory in every respect.

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AMERICAN ACADEMY OF OPTOMETRY

IN MEMORIAM

Anno Domini

1954

Dr. J. P. Davey, Indianapolis, Indiana.

Dr. Howard C. Doane, Boston, Massachusetts.

Dr. G. A. McBurney, Pasadena, California.

Dr. John C. Patty, Kingsport, Tennessee.

Dr. Joseph Ziff, Los Angeles, California.

Since our last annual meeting the Academy has lost five of its members through death. Each of these men played a significant part in the development of the profession and each by his splendid work has left his important mark on the present and future of optometry. All have been active in the Academy. We miss these important leaders and the membership of the Academy at this time pays tribute to their memory.

(From the minutes of the Toronto, Ontario, Canada, meeting of the Academy.)

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SUGGESTIONS FOR CHAPTERS—THEIR FORMATION AND OPERATION*

The American Academy of Optometry, by permission granted in the By-Laws, encourages the formation of Chapters by its members and issues charters to such organizations. Chapters are formed for the convenience of Academy members. They make possible close professional ties between local members and the national Organization, itself. To some degree, it is in the Chapters that many Academy members acquire the sense of "belonging-to" the Academy. It is felt that this is desirable and mutually beneficial.

Since members benefit through their association in Chapters, they have in return some collective responsibilities. These include carrying to the public and to the profession the prestige and high esteem of the

*By Harold Simmerman, O.D., Member of Faculty, Pennsylvania State College of Optometry, and Lawrence Fitch, O.D., Dean, Pennsylvania State College of Optometry.

Academy; making the personality and character of the Academy attractive to non-members; and last, living constantly up to the aims, the standards and the scientific interests of the Academy. The successful operation of a Chapter can be measured by how well these responsibilities are achieved.

As important as Chapters are to the operation of the Academy, they are not actually an integral part of its administrative organization. The Academy is an organization of individuals, and thus a Chapter has actually less privilege and franchise than an individual member, as the Chapter cannot vote, it cannot hold office, and it does not hold representation in any part of the Academy's governing body.

The Academy wishes to encourage the creation of Chapters, and its Executive Council has given considerable study to their formation and operation. *The Committee on Charters and Formation of Chapters* is ready to assist in the organization and development of new Chapters. Members may write the Committee Chairman or the Secretary of the Academy regarding new Chapters or Chapter problems.

The purpose of this report is to explain past actions and policy of the Executive Council on these matters so that members of the Academy may have a ready source of reference to many of their questions and problems. Members who have problems at the Chapter level may secure help by referring to the By-Laws of the Academy as these relate to Chapters and by identifying the Council's past actions directly to Article 7 with its 8 Sections.

Article 7. Academy Chapters. Realizing that the objects of the American Academy of Optometry are best served by a continuous exchange of ideas between the annual meetings, Fellows are urged to form local Chapters. The American Academy of Optometry recognizes that some measure of local autonomy is to the best interests of itself and the local Chapters. The following, therefore, are merely the requirements for obtaining and keeping a Charter as a Chapter of the American Academy of Optometry.

In this prologue are written the reasons for the existence of Chapters. These are, that it is in Chapters that "the objects of the Academy are best served" because they afford an opportunity for the "continuous exchange of ideas between annual meetings." Although these may be the constitutional reasons for Chapters, these local organizations have many other functions which will be reviewed. In many respects a Chapter has the same functions, aims and ideals as does its parent body, and has the same reasons for functioning as does the Academy. The Executive Council requests that in their operation the Chapters identify themselves with the functions, aims and ideals of the Academy.

The "local autonomy" in the prologue of Article 7 refers only to self government and programming and in no way permits Chapters to

alter Academy objectives or standards.

Section 1. Applications for a local Charter of this Academy will be considered by the Executive Council when signed by three Fellows in good standing, residing in local Chapter zones.

Any three or more members of the Academy may form a Chapter, provided their geographical locations lend themselves to such an effort. The formation of a Chapter requires these members to sign a written request to the Executive Council petitioning it for a Charter. These members become Charter Members and assume the responsibility of determining the available number of Academy members in their area, or at least the potential eligible membership in order to judge the advisability of forming a Chapter. They also suggest the area or zone that they wish the Chapter to cover geographically.

Section 2. Upon approval of the application, the Secretary will prepare a Charter which will be duly signed and executed by the Executive Council. The Council will designate the territory to be covered by the local Chapter.

The Executive Council, during the entire thirty-three year history of the Academy, has always granted Charter requests. Action has never been strict as to the designation of "territory" in regard to the Chapters, but rather the question of territory has been left to the decision of the Chapters themselves. In areas where Chapters are relatively close together, Academy members have been left free to join the Chapters of their choice or to remain free of Chapter affiliation altogether.

Chapters usually identify themselves by geographical names, and these names commonly designate their "spheres of influence," but often these names signify only their "areas of origin" or their "constitutional seats."

The granting of Charters is usually done at an annual meeting of the Academy in a simple ceremony during the banquet.

Section 3. Local Chapters of this Academy shall operate and be bound by a constitution and by-laws supplied or approved by this Academy.

The Executive Council is of necessity quite fixed in its policy concerning Chapter Constitutions and By-Laws and recommends that Chapters adopt the Academy's Constitution and By-Laws rewritten to meet the needs of the Chapter, thus preventing conflict with fundamental Academy policy. After adoption, the Chapter's Constitution and By-Laws should be sent to the Secretary of the Academy for approval by the Executive Council.

Any Academy Chapter member may question any part of a Chapter's Constitution or By-Laws if he thinks it conflicts with Academy policy. The contention will be resolved by the sending of the Chapter Constitution and By-Laws in question, together with the problem, to the Secretary of the Academy for consideration by the

Executive Council. Careful consideration must be given in the writing of Chapter By-Laws and the suggestions which follow Section 4 should be observed closely.

Section 4. Local Chapters may make any additional rules for the conduct of their affairs, provided they are not in conflict with basic principles of the Academy.

Here the Executive Council permits the full application of local autonomy as this applies to self government and programming. In taking positions on new matters the Council advises that Chapters should first investigate to determine if the Academy has not already made a ruling or considered a policy covering the situation. If it has, contrary action by the Chapter is precluded, although the Chapter, naturally, may open the matter for further study by the Academy itself. It is suggested that Chapters be responsible for keeping their actions in accordance with general Academy precedent and policy. Questions which may arise between Chapter actions and Academy principles should be placed before the Executive Council for consideration and decision.

Section 5. A Chapter may on application to the Executive Council establish its own Committee on Admittance to function under the jurisdiction of the Committee on Admittance of the Academy. The Chapter Committee shall be composed of Fellows of the Academy.

In order to create a Chapter Committee on Admittance it is advisable for the Chapter to submit three names of its Fellows to the Secretary of the Academy, designating one of them as Chairman. The Secretary shall then submit the three names to the Chairman of the Committee on Admittance of the Academy for his approval, and he in turn shall submit these names to the President of the Academy for appointment and confirmation by the Executive Council.

After the Committee on Admittance of the Chapter has been appointed, no changes of personnel on this Committee should be made by the Chapter unless the appointment procedure is repeated. This is necessary to enable the Chapter Committee to understand fully the procedure followed by the Committee on Admittance of the Academy and to ensure that the latter Committee shall always have the correct record of the names of committee members with whom to work in each of the Chapters. It is the Chapters responsibility to follow this procedure to enable the Academy Committee on Admittance to function in the best interests of the Applicant.

Although it is not a requirement for service on this Committee, it is suggested that the Chapter submit the names of one or more Fellows who have attended annual meetings of the Academy and have observed the Committee on Admittance in operation. Equally important is the choice of three Fellows who are geographically representative of the

Chapter area.

The Committee on Admittance of the Academy utilizes Chapter Committees on Admittance for important parts of the processing of Academy applicants. The parts delegated to the Chapter Committee are: (1) Reporting on the character of the applicant and the physical aspects of his office; (2) Administering and evaluating the Clinical Examination of the applicant; and (3) Administering and evaluating the Written Examination of the applicant.

It should be noted that Chapter Committees on Admittance (within the Continental United States) are never given the privilege of holding applications for membership for investigation. Also they are not required to process the application fully. This is done only by the Committee on Admittance of the Academy. Also, the Chapter Committees on Admittance do not evaluate the written case reports submitted by the applicant. The Chapter Committees work directly under and with the Academy Committee on Admittance, and while they are expected to report on the worthiness of an applicant they cannot make the final decision on his acceptance or rejection to membership. This is the duty of the Executive Council working upon information furnished by both the Chapter and the Academy Committee on Admittance.

The policy of the Committee on Admittance is to request a recommendation on the applicant from the local Chapter Committee on Admittance. In all cases these reports are given most careful consideration. While all applications are held in possession of the Academy every effort is made to cooperate with the Chapters in the important matter of processing applications.

Section 6. Local Chapters will make an earnest effort to induce all eligible and desirable optometrists to make application for Fellowship in the Academy.

The Executive Council suggests that all letters of application for membership in the Academy be made directly to the Secretary. All completed application forms should be sent directly from the applicant to the Secretary. They may also be sent through Chapters or Academy members. However, an applicant living or practicing in a Chapter area may become a member of the Academy without applying through or to the Chapter, but the Chapter will be consulted on the applicant's qualifications (Section 5) while the application is being processed. Chapters are not charged with receiving applications and do not act upon them, except as mentioned in Section 5. They are requested to encourage eligible optometrists to apply and then to aid these applicants in fulfilling their membership requirements.

Academy members are strongly urged to refrain from recommending applicants for Fellowship who are borderline in any of the aspects

of Academy standards of eligibility. Borderline applicants should not be permitted to file an application, but if an ill-advised application does become filed, the Chapter Committee on Admittance should recommend that it be dropped immediately so that it does not reach a point in processing that would be embarrassing to the Chapter, to the applicant or to the Academy.

It is to be further observed that this By-Law reads, "All eligible and desirable optometrists . . ." Therefore, the Academy does not permit a Chapter to limit the number of members of the Academy in a given geographical area. Also, the Chapter should not limit its own membership to any predetermined number of members.

As this is a scientific and educational body, applicants of every creed and color are welcome to apply.

The Executive Council further suggests that all optometrists become members of the Academy before becoming members of a Chapter. While Academy members are not required to join a Chapter, all members are urged to do so. On the other hand, a Chapter is permitted its choice in accepting or rejecting any member of the Academy into its membership.

In commenting on the above, the Executive Council suggests that the classification of memberships in the Chapters be the same as in the Academy. This practice would preclude any such non-Academy designations of members in Chapters as "probationary," "tentative," "member-elect," etc. If a Chapter wishes to permit a non-member to attend its regular meetings to aid and encourage him in processing his Fellowship requirements, it is suggested that the Chapter give this permission in the simple status of "Guest in Attendance." This is done in some Chapters not only to assist in processing applicants but to encourage and indoctrinate Academy standards into newly eligible optometrists who have not as yet completed the required three years in professional practice or teaching.

Section 7. A Charter will be considered active only when at least two meetings are held each year and a complete report on each meeting is sent to the secretary of the Academy.

Within the limitations of this section, the operation of a Chapter is left to its officers and its membership. The Academy has never upheld the "complete report" part of this section, although many Chapters do send in complete reports which are used in full or in part in the issues of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY so that the profession may be informed of the program held by the Chapters. These reports also assist other Chapters in developing their programs. In this respect, Chapters are urged

to emphasize the value of attending the Academy's annual meetings, where much program material and ideas can be brought back to the Chapters for their use.

The following are suggested methods of programming Chapter meetings: (a) Have Fellows within the Chapter present papers: (b) Invite speakers from other health professions: (c) Use the original papers published in the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY for group review, designating discussion leaders from the Chapter: (d) Conduct panels on various optometric subjects: (e) In conjunction with local institutions conduct project conferences, or clinical research on visual problems: and (f) Organize clinical courses by arranging for a speaker or group series of speakers on practical clinical subjects.

Section 8. The Charter of a Local Chapter may be revoked or suspended for cause by a majority of the Executive Council.

Although the right of revocation or suspension is hereby retained by the Executive Council, in the history of the Academy this right has never been exercised. Occasionally, actions of the Chapters have provoked the Executive Council to mild disciplinary action, but in very great part there exists a fine relationship between the governing body of the Academy and the individual Chapters.

Chapters are given wide autonomy in their operations and conduct. The Chapters have exercised their freedoms wisely: wherefore the Executive Council is grateful to them for their part in the Academy's continued growth and for their aid in bringing the Academy to the strong position in the profession which it now enjoys.

LAWRENCE FITCH
HAROLD SIMMERMAN

ANNOUNCEMENT

CAREER AS AN OPTOMETRIST

The Institute for Research, Chicago, has recently published its 1954 monograph 27, "Career as an Optometrist." This 20 page plus cover booklet reviews the education and professional work of an optometrist. It is one of a series of booklets dealing with professions and results from vocational research carried on by the Institute. Dr. Harry E. Pine, Chicago, Chancellor, Beta Sigma Kappa, assisted in editing the monograph. Copies may be secured from the Institute for Research, 537 South Dearborn Street, Chicago, Illinois. The cost is $1.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ANNUAL REPORT OF THE PRESIDENT*

Meredith W. Morgan, Jr.†
School of Optometry, University of California
Berkeley, California

If we were to characterize this year of 1954 in the history of the American Academy of Optometry, we could do no better than borrow the phrase which was supposed to describe the education of our parents; namely, "readin', writin', and 'rithmetic."

Some of the reading has involved the writings of various members of your Executive Council and its committees. First, our manual, "The Objects of the Academy and Manual of Instructions for Applicants" has been entirely re-written. Second, the Committee on Research Projects now has a written declaration of policy, methods and procedures, "Research Grant Procedures of the American Academy of Optometry." Third, the Committee on Chapters and the Admittance Committee in cooperation have prepared a manual for chapters, "Suggestions for Chapters—Their Formation and Operation."

Some of the reading has been of the writings of Dr. Charles Sheard. The *Sheard Commemorative Volume* has been read in its entirety by several members of the Executive Council. This manuscript is now nearly ready to be submitted to a printer. The final publication of this Volume will mark a milestone on the road of Optometry as well as of the Academy, and the Science of Seeing in general.

Arithmetic has always been with us. As each of us is well aware a solvent enterprise must have an income which slightly exceeds its outgo. Our income is largely dependent on the dues collected from the Fellows who belong to the Academy. This year we are requesting that the scientists and educators, who have the rank of Associate Professor or higher, pay the full dues. This will increase our income and allow us to underwrite more research and thus advance Optometry. All of you have received in the mail, about the middle of November, a copy of our treasurer's report. If you read this carefully, you will have noticed that we came through this year in the black.

*Read before the annual meeting of the American Academy of Optometry, first business session, Toronto, Ontario, Canada, December 11, 1954.
†Optometrist, Ph.D. Member of faculty, Fellow, American Academy of Optometry.

Another place where arithmetic enters the picture is in the count of Fellows of the Academy. You will soon hear the report of the Secretary and you will note that the Academy continues to grow. This year our Admittance Committee, under the able direction of Dr. Harold Simmerman, has done an outstanding job. Harold is the "writinest" chairman that this committee has ever had. He is in continuous correspondence with our applicants: encouraging, cajoling and even, at times, mildly threatening.

Each Fellow of the Academy should accept the responsibility of cooperation with the Admittance Committee. Every eligible optometrist in your area should be contacted and urged to join with us. We do not contemplate a mass drive for members but we want to be sure that everyone eligible for Fellowship in the Academy knows what the Academy is and what it stands for. An enthusiastic Fellow must of necessity be one who promotes the Academy.

This year the Academy was again represented at the Annual Congress of the American Optometric Association by your President and Secretary and by nearly one hundred Academy members. The Executive Council of the Academy believes that Optometry must have a strong political, as well as a strong scientific, association. The Academy has continued this year its efforts of cooperation with the American Optometric Association and urges each individual Fellow of the Academy to be active in his State association of the A. O. A.

The Executive Council appointed a committee to study the advisability of first, the establishment of honorary lectureships and second, the establishment of study courses at our annual meetings. This committee has a report ready for the consideration of the Academy. If we decide to follow through on this plan, we will not be pioneers in that several sister societies now have such plans in operation.

The results of the work of another committee will soon be known to you. The Papers and Program Committee, under the very able leadership of Dr. John D. Perry, Jr., has put together another excellent program.

It has been the responsibility of Dr. Perry and his Committee to carry out the first purpose of the Academy, to afford "an opportunity for the presentation and discussion of the results of clinical and experimental research in visual problems." You will soon know that in fulfilling its first purpose, the American Academy of Optometry will come through this year with flying colors.

As I draw near the end of my final year as President of the American Academy of Optometry, I can truthfully look back at these

two past years with pleasure. My only hope is that I have in some small way repaid you for the confidence you have demonstrated in me by electing me President of the Academy. Any service that I have been able to perform has been largely the result of the splendid organization that is the Academy. This year every committee has functioned as it should. It has been very satisfying to know that there are able men willing to accept responsibility and willing to fulfill the responsibilities that they accept. The list of men who deserve my thanks is too long to mention here. It includes not only every member of the Executive Council and all committee chairmen but also every member of every committee.

COMMITTEE APPOINTMENTS FOR 1955

Dr. John D. Perry, Jr., president of the American Academy of Optometry, announces the following committee appointments for 1955. These appointments have all been confirmed by the Executive Council and the members named have accepted their assignments.

SECTION ON ANISEIKONIA

Dr. O. L. McCulloch, chairman, Holyoke, Mass.; Dr. R. E. Bannon, Southbridge, Mass.; Dr. E. W. Bechtold, New York City; Dr. G. M. Belanger, Ottawa; Dr. B. Freeman, Allentown, Penna.; Dr. H. M. Fisher, New York City and Dr. W. P. Schumann, Vineland, N. J.

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Dr. B. Mazow, chairman, Houston; Dr. E. Freeman, Chicago; Dr. I. Finkelstein, New York City; Dr. R. C. Graham, Pasadena; Dr. J. C. Neill, Philadelphia; Dr. W. W. Policoff, Wilkes-Barre and Dr. S. G. Weiss, Torrington, Conn. The above committee also serves as the Examining Board of this Section.

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SECTION ON ORTHOPTICS

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SECTION ON PATHOLOGY

Dr. M. J. Hirsch, chairman, Ojai, Calif.; Dr. D. D. Michaels, Chicago; Dr. H. Simmerman, Wenonah, N. J.; Dr. R. Walsh, Bloomington, Ill., and Dr. H. Wolfe, Marshalltown, Iowa.

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Dr. V. J. Ellerbrock, chairman of the Committee on Instruction, Columbus; Dr. D. G. Hummel, chairman of the Committee on Administration, Cleveland. The other members of these committees will be announced in a later issue.

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CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

N. I. C. O. AND C. C. O. MOVING TOWARDS CONSOLIDATION

At the time of going to press there is every indication that the Northern Illinois College of Optometry and the Chicago College of Optometry will consolidate. The first of a series of final steps in this important move in optometric education was taken by the Boards of Trustees of both schools meeting jointly at the Schroeder Hotel, Milwaukee, January 23. This meeting was the culmination of a series of conferences held during 1954. Since the Milwaukee meeting, officials, of both Boards have had several additional meetings in Chicago at which progress towards final consolidation was made.

It is reported that the new college will be called the *Illinois College of Optometry* and that the headquarters will be located on the campus of Illinois Institute of Technology, Chicago, in the new building put up by the Chicago College of Optometry during 1954. For the time being the school clinics will probably be continued in their present locations. It is planned that the class rooms and laboratory teaching facilities will be consolidated on the Michigan Avenue site and the two student bodies will merge as soon as practical. Most faculty people of both schools will be retained in the new enlarged institution.

At the January 23 meeting it was agreed to retain the personnel of both boards and the new Board of Trustees of the consolidated school will be composed of the following 12 members: Dr. John J. Brady, Sheldan, Iowa; Dr. Margaerite T. Eberl, Milwaukee; Dr. Malcolm E. Edwards, Decatur, Alabama; Dr. Rudolph Ehrenberg, Granite Falls, Minnesota; Dr. Samuel Hauser, Chicago; Dr. Felix A. Koetting, St. Louis; Dr. Carel C. Koch, Minneapolis; Dr. Walker H. Matthews, Athens, Georgia; Dr. Glenn Moore, Chicago; Dr. Eugene W. Strawn, Freeport, Illinois; Dr. Oscar Weinstein, Rockford, Illinois, and Dr. Henry L. Wolfe, Marshalltown, Iowa.

At the meeting Dr. Glenn Moore, Chicago, was elected Chairman of the new Board of Trustees. Dr. Moore will also serve as Chairman of a small Executive Committee of the Board. The executive committee will meet frequently in Chicago at the college.

Dr. Eugene W. Strawn, Freeport, was elected President of the

College. With Dr. Moore he will supervise the consolidation of the schools which is expected to go forward with vigor.

The officers of administration of the consolidated school will be, Dr. Richard Feinberg, Chicago, Vice-President and Dean of College. Dr. Morton Abram, Chicago, Vice-President in Charge of Administration. Dr. Frederick Kushner, Chicago, Director of the Department of Optometry, and Dr. Edward R. Tennant, Chicago, Director of Clinics.

The consolidated boards also agreed to bring the two alumni associations into one organization as soon as practical and to vigorously culminate existing litigation.

NEWS BRIEFS

The Better Vision Institute, 630 Fifth Ave., New York City, will soon launch a $500,000 promotional campaign for eye care. Key themes will be developed, such as professional eyecare, need for proper lenses for a particular job, the "wardrobe" glasses idea, style in eyewear and eyewear obsolescence. Emphasis will be placed on the need for good vision on the job, in the classroom, on the highways and in sport activities. If you have not paid your B. V. I. dues for 1955—this is the time to do so. Send in your check for $15 today to support this outstanding program. . . . Dr. John J. Sullivan, Professor of Psychology at the New York University School of Education spoke before the New York Academy of Optometry, January 18. His paper was, "Some Implications for the Optometrist of Recent Psychological Researches in Visual Perception." . . . Dr. Roy Marks, vice-president of Shuron, points out that they have just made the eight millionth Browline frame. . . . Dr. Fred W. Jobe of Bausch & Lomb was the commencement speaker at the January convocation of Chicago College of Optometry. . . . Dr. D. R. Reed, LaPorte, is the newly elected president of the Indiana Optometric Association. . . . The American Optometric Association announces March 6-12 as "Save Your Vision Week." . . . Mr. Joseph A. Hueber of Kelley and Hueber, was elected president of the Optical Manufacturers Association in New York City, January 20. . . . A Rodenstock refractometer was presented to the free public eye clinics of the Pennsylvania State College of Optometry by the Stitch-in-Aid Society. . . . The next Optical Fair will be held in 1957. . . . The National Council to Combat Blindness, 30 West 59th Street, New York City, has announced a grant-in-aid to Dr. V. J. Ellerbrock, School of Optometry, The Ohio State University for the preparation of a volume on subnormal vision; evaluating the aids currently available for subnormal vision correction and for making recommendations for the development of new aids.

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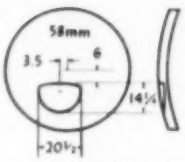

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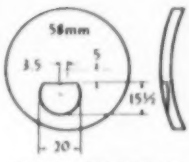

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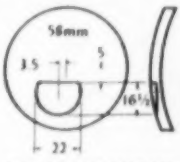

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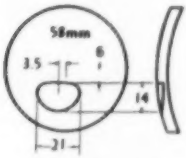

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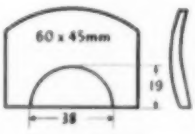

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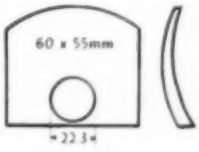

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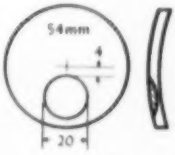

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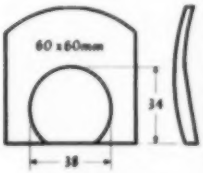

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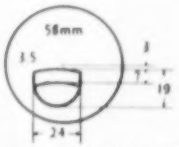

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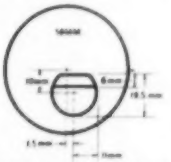
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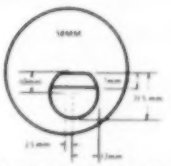
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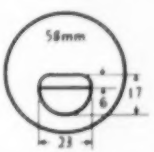

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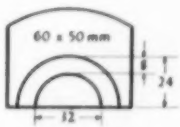

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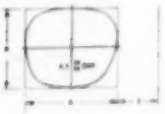

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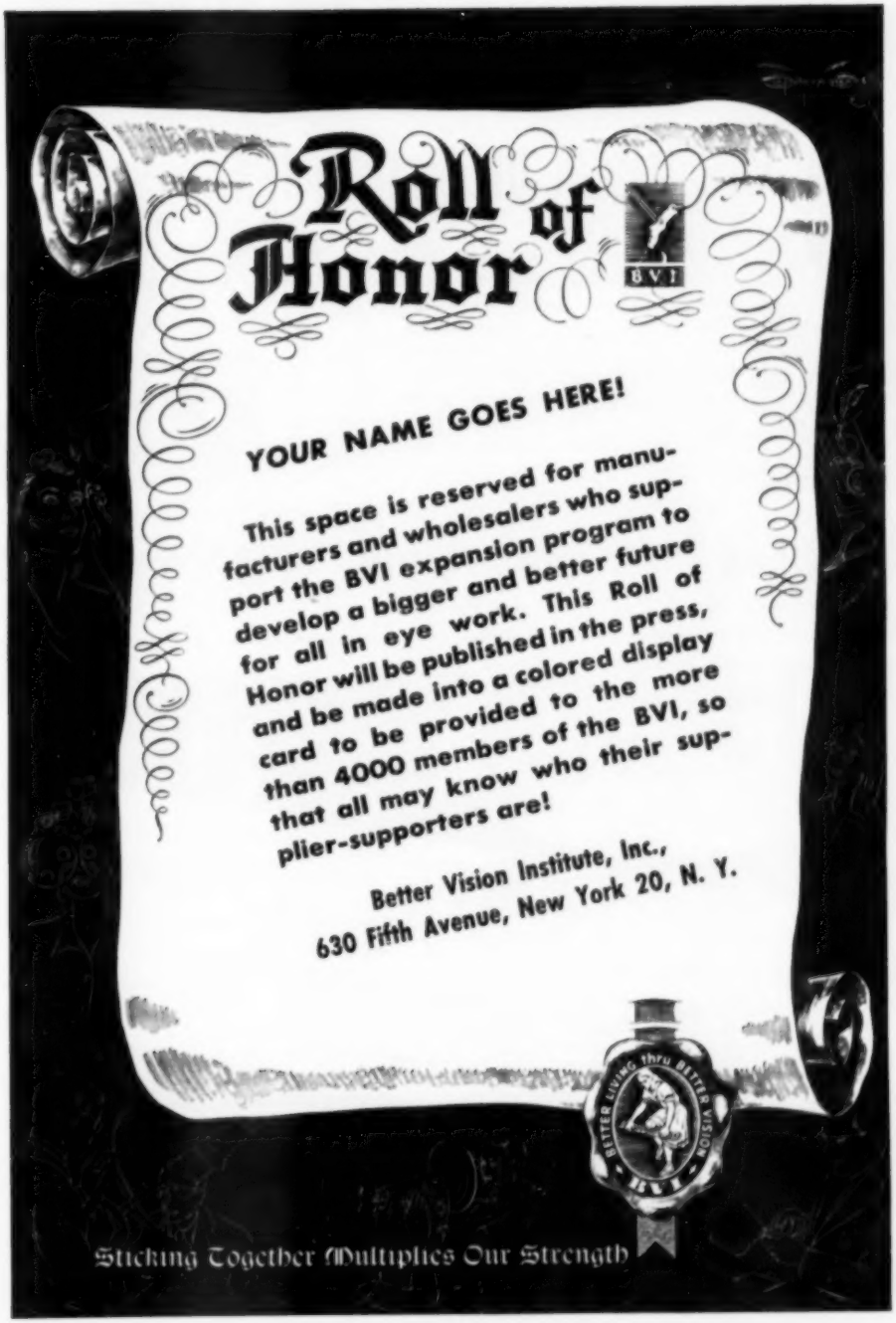
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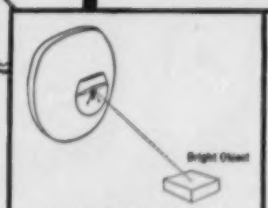
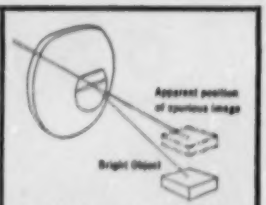


Nu-Line 7 CV with treated lines. Light is diffused downward or absorbed.



3-foci lens with untreated lines. Light is refracted off line into eye.

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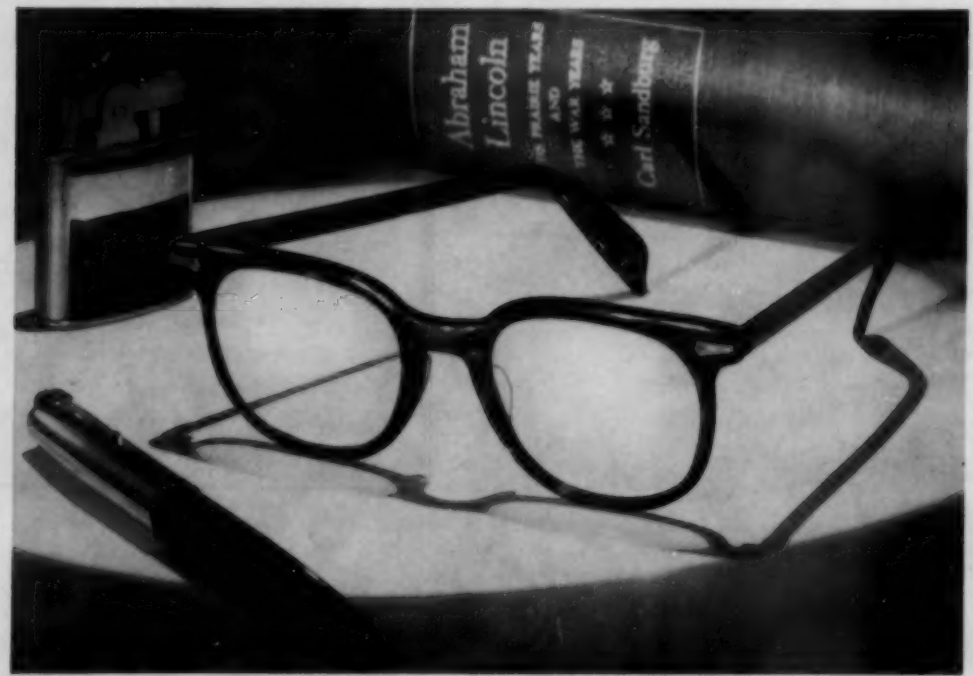

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